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OPERATION AND MANAGEMENT OF MILK PLANTS[1]

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THE NEED FOR TECHNICAL KNOWLEDGE

The operation and management of a milk plant requires, besides general ability, considerable technical knowledge and training. New milk plants are constantly being established, especially by organizations of producers or of producers and small dealers, and the selection of a competent manager is essential, because the success of such plants depends primarily on the manager. Capable men are often difficult to find. Some men have the proper personality and business and executive ability, but lack the technical knowledge required for successful plant operation. This circular gives basic information on the methods of operating milk plants which have proved to be satisfactory in practice, and discusses certain phases of management which are directly related to successful operation.

The construction, arrangement, and equipment of milk plants have been discussed in other publications issued by the Department of Agriculture (*4*, *6*, *8* [2]).

[1] This circular supersedes Department Bulletin 973, Milk-Plant Operation.
[2] Italic numbers in parentheses refer to Literature Cited, p. 49.

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SYSTEMS OF BUYING MILK

A few years ago, by far the larger part of the milk handled by city milk dealers was bought from producers on the basis of measure, that is, by the can or by the gallon. Dealers as well as producers have recognized the inaccuracy of this system and its unfairness both to buyers and to producers, so that in recent years the tendency has been to abandon it and adopt systems more nearly equitable and at the same time practicable.

BUYING MILK BY WEIGHT

Although most milk dealers now weigh the milk as it is received and pay the producer on a hundredweight basis, a few dealers still use the measure system, and measure the quantity received from the producer by cans or gallons. In a study by this bureau of the shipments of milk into one city, comparison was made of the quantity of milk received as determined by measure and as determined by weight. Observations were made on a total of 346 shipments of milk, consisting of 1,102 cans. The cans were examined on arrival at the plants, and the quantity of milk in cans that were not full was estimated by means of measuring sticks, so that an accurate check of the quantity of milk received as determined by measure was made before the milk was emptied into the weigh cans. The difference between the quantity of milk received as determined by volume measurement and the actual quantity received as shown by the scales, for the 346 shipments, was as follows:

Cans received	number	1, 102. 00
Milk received as determined by can measure	gallons	6, 185. 32
Milk received as shown by scales	pounds	52, 191. 00
Actual milk received as determined by weight (at 8.6 pounds per gallon)	gallons	6, 068. 72
Shortage as indicated by weight	do	116. 60
Percentage of shortage		1. 88

Thus the difference for the total quantity of milk received was 116.60 gallons, or 1.88 per cent. The inaccuracies of measuring by volume or number of cans received were to a large extent due to poor cans, many of which were dented and battered.

Inaccuracies in determining the quantity of milk received that result from measuring by cans are due principally to the following causes: The cans are not filled completely by the producers; milk is spilled or leaks in transit; and cans which do not hold the specified quantity because of dents or other defects, are used.

Milk producers as well as distributors now quite generally recognize that all milk should be weighed when it arrives at the plant.

BUYING MILK ON THE BUTTERFAT BASIS

While formerly little attention was paid to the butterfat content of the milk when prices were arranged between the producers and the distributors, practically all milk is now paid for by distributors according to the butterfat test, which has come to be considered the most important single factor in determining the grade of the milk.

The most common method of fixing prices according to the butterfat test is to quote a certain price per 100 pounds for milk of a definite butterfat content. To this base price a certain amount per 100 pounds of milk is added for each additional 0.1 per cent (or "point")

of butterfat in the milk, or an equal amount per 100 pounds is deducted for each point that the milk falls below the basic test. For example, if the price is $2.80 per 100 pounds of milk testing 3.5 per cent butterfat, with an allowance of $0.05 for each point above or below this butterfat content, the price for 100 pounds of 4 per cent milk would be $2.80+(5×$0. 05), or $3.05, while the price for 100 pounds of 3 per cent milk would be $2.80−$0.25, or $2.55. In some sections milk plants quote a price of so much per pound of butterfat for milk containing up to a certain percentage of butterfat, and an additional sum, which is usually relatively less than the base price per pound of butterfat, is allowed for each pound of butterfat above the basic percentage that the milk contains. For example, the price may be quoted as 70 cents per pound of butterfat for milk containing up to 4 per cent butterfat, or 4 pounds of butterfat per 100 pounds of milk, with an additional 50 cents for each pound of butterfat in the milk above the 4 per cent base. Thus the price for 100 pounds of milk testing 4 per cent butterfat would be 4×$0.70, or $2.80, and for 100 pounds of milk testing 4.5 per cent butterfat the price would be $2.80+(0.5×$0.50), or $3.05.

There is no standard system of quoting prices on the butterfat basis. In some markets the price quoted for milk may be based on milk testing 3.5 per cent butterfat, and in others on a test of 3.8 per cent butterfat, and in still others on a test of 4 per cent butterfat. The difference allowed or deducted per 100 pounds of milk for each 0.1 per cent or point of butterfat that the milk tests above or below the basic percentage, will also vary from 3 to about 6 cents in different localities. In general, it may be said that the basic test agreed upon between the distributor and producers should be as near as possible to the test of the milk put out by the distributor, and the differential added or deducted should be as near as possible to the value of butterfat in the form of sweet cream or butter. If the differential for extra butterfat is set much below this point, it will tend to encourage the producer to cull out his high-testing cows, or even to separate out some of the fat from the milk. On the other hand, if the differential is set much above the market value of butterfat, in the form of cream or butter, the milk distributor would lose money on high-test milk, as he would not be able to dispose of the extra butterfat except in the form of cream or butter. Usually all milk received by the distributor except special milks is mixed in the plant and the product put out is standardized to a uniform butterfat content, and is sold by the distributor at one price. Therefore, he can not afford to pay for extra butterfat in the milk above this standard test, a higher differential than the extra butterfat would be worth to him in sweet cream or butter. Futhermore, if the differential is set too high, it might cause some producers to separate some of their milk and add cream to the whole milk. This would result in milk deficient in solids not fat and total solids.

BUYING MILK ON A QUALITY BASIS

While various systems have been adopted by some milk plants to encourage producers to produce milk of extra quality from the standpoint of cleanliness or low bacterial count, such systems are not in very common use. Where milk is bought on a quality basis special grades are usually established, and premiums are paid for milk of

extra grade. Specially clean milk requires extra attention and extra equipment in its production, and should command an extra price. Usually these special grades of milk command a premium of 2 to 3 cents per quart from the consumer over the regular grade of milk. The factors most commonly used in such classifications are: Bacterial count of the milk; dairy-barn score; and health of the cattle. Other factors which are used are based on sediment test, degree of acidity, flavor and odor, and temperature of milk delivered to the milk plant.

MILK-BUYING PLANS DESIGNED TO REGULATE THE QUANTITY OF MILK PRODUCED

While milk consumption will vary somewhat from day to day and from week to week, these variations are not great and the consumption of milk throughout the year tends to be relatively stable and uniform. However, production tends to vary greatly through the year, and, furthermore, consumption tends to fall off during the spring and summer when production tends to increase. During the fall, when production is the lowest, the distributor must receive from his producers enough milk to supply his regular trade and take care of any increase in consumption. As he must carry these same producers throughout the year, he will receive a considerable amount of surplus milk during the spring when production is highest. During the last few years various buying plans designed to make production coincide as far as possible with market demands have been adopted. In general, three main plans of this type have been adopted in different sections of the country. These are: (1) The basic-surplus price plan; (2) the classification or use price plan; (3) the combination price plan. There are many modifications of these three general plans.

THE BASIC-SURPLUS PRICE PLAN

Under the basic-surplus price plan the milk producer is compensated for producing a uniform volume of milk throughout the year. A basic quantity is established by each producer, for which the distributor pays the class 1 or market-milk price. For all milk produced above his basic quantity, the producer receives a lower or "surplus" price. Usually the fall months, as October, November, and December, are used as the base period during which the producer establishes his basic production. These are the months when production tends to coincide most nearly with consumption. Sometimes the production for the previous fall months is used as the basic production, whereas in other cases the average production for these three months over a period of years may be used. In some localities the producer is allowed to determine his basic quantity by contracting to deliver a definite quantity for the year. The price for class 1, or market milk, is determined in advance at meetings of representatives of the distributors and of the producers, and this price depends on such factors as market demands, business conditions, cost of production, etc. The price for surplus milk is usually based on its value for use in milk products. Under this plan the producer is given an incentive to produce a uniform quantity of milk throughout the year.

THE CLASSIFICATION OR USE PRICE PLAN

The plan of basing a price classification on use of the milk recognizes the fact that milk in different forms has different values and the

prices paid under this plan vary according to the use that is made of the milk. The quantity of milk going into the various classes is determined from the records of the distributors, showing the uses to which the milk was put. In some cases, provision is made for at least four classes of milk, each being paid for at a different price, as for example, class 1, all milk sold in fluid form; class 2, milk made into cream that is sold in fluid form; class 3, milk made into manufactured products, except butter; and class 4, milk used in the manufacture of butter. In some instances all milk not sold in fluid form is used in the form of cream. In that case only two classes are required. The price established for class 1 milk is usually based on market conditions, such as probable total production in relation to demand for milk in fluid form. Prices for the other classes are usually based on market quotations for cream, butter, cheese, and other products.

THE COMBINATION PLAN

In some localities the principal features of the basic-surplus price plan and the classification or use price plan have been combined into one plan. Usually where this combination plan is used, the milk is sold to the distributors by the producers' association in accordance with the classification or use plan, and the returns to the individual producers are made in accordance with the uniformity of their production; that is, the distributors pay the association for the milk according to the uses they make of it, as under the classification or use price plan, and the association pays the individual producers according to the basic-surplus plan, each producer being assigned a basic production for which he receives class 1 prices. Thus, the producer is given an incentive to coordinate his production with market demands and the distributor pays for the milk he receives according to the uses he makes of it. Under this plan the sums withheld from those producers who produce a varying quantity of milk throughout the year are usually put into an adjustment fund, from which compensations are paid to those producers whose production is more uniform. There are a number of modifications of this plan.

RECEIVING MILK AT THE PASTEURIZING PLANT

The milk as received from producers, directly or through country receiving and cooling plants, is usually brought to the pasteurizing plant in cans by motor truck, either from the railroad station or directly from the country. The trucks are unloaded at the receiving platform, the milk is graded and dumped, and the cans are washed and returned to the trucks, to go back to the producers and be filled again with milk. Much milk is also received in tank cars and tank trucks, especially at large plants (p. 7).

All milk should be received at the plant in the morning, if possible. It is usually desirable to have all of the day's supply in before noon, so that none of the milk will be hauled in the heat of the day and the work of receiving it at the plant can be completed in good time. (Fig. 1.)

The milk-plant manager is responsible for the quality of the milk put out at the plant, and he should require that milk be properly cared for at the farm where it is produced. The advantages of keeping milk clean and sweet should be pointed out. One of the most important points is keeping the milk cool. Producers should be in-

structed to begin early in the spring to use ice to cool the milk. Usually more sour milk is received at the plant in the spring and fall than during the summer, because many producers fail to realize the importance of cooling at these times and do not begin to use ice early enough nor continue its use late enough.

GRADING, SAMPLING, AND TESTING

The milk should be dumped and weighed as soon as it arrives at the plant. Each can must be examined to determine its condition. (Fig. 1.) This may be done by smelling or tasting, and any milk with objectionable flavor or odor should be rejected. Experienced men can usually detect off-flavored milk by smell. If it is necessary to taste the milk, a separate spoon or other utensil should be used for each can, and such utensils, unless they are of the single-service type

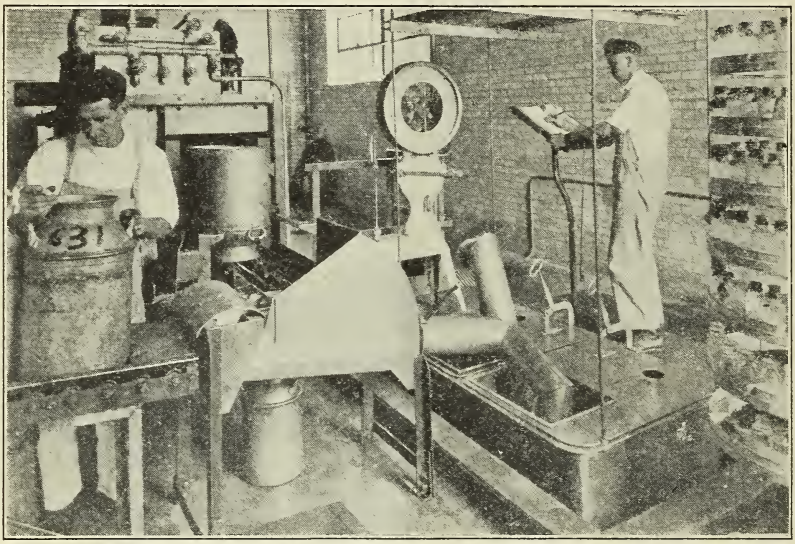

FIGURE 1.—Receiving milk at a pasteurizing plant. Man at left is taking the temperature of the milk. He also inspects it for flavor and odor, dumps it, and places the can in the can washer. Man at right records the temperature and weights. Rack for butterfat samples is partly visible at extreme right

which can be destroyed after use, must be thoroughly washed and heated in boiling water or steam before being used again.

After the milk is dumped into the weigh can and thoroughly mixed, a sample should be taken for the butterfat test. (Fig. 2.) At plants where the milk is weighed in the cans, the sample is taken directly from the can and in that case care must be taken to mix the milk in the can thoroughly before taking the sample. Except for very small plants, however, a weigh can is desirable, because it makes it possible for all the milk of each producer to be thoroughly mixed in the weigh can and a representative sample taken. Many plants also make an acidity test as a check upon the condition of the milk when it comes in. Information on testing milk and cream is given in a publication on that subject issued by the Department of Agriculture (*15*).

In order to determine the bacterial content of the milk as it is received, samples should be taken periodically for bacterial analysis. Either a plate count or a methylene-blue test may be made. The methylene-blue test is simple and easily made. Most large plants have their own laboratories for making the plate count, but in small plants it is usually necessary to have this done by a commercial laboratory or the local health department (*2*).

After the milk is weighed, it usually goes to a preheater, where it is heated to approximately 90° F. before going through a filter or a clarifier (*6*). Many plants, however, clarify the milk cold with satisfactory results. At very small plants, where it is not desired to purchase a commercial filter or clarifier, satisfactory results may be obtained with a filter consisting of filter cloth or of layers of cotton and cheesecloth. The milk passes through this filter as it is dumped

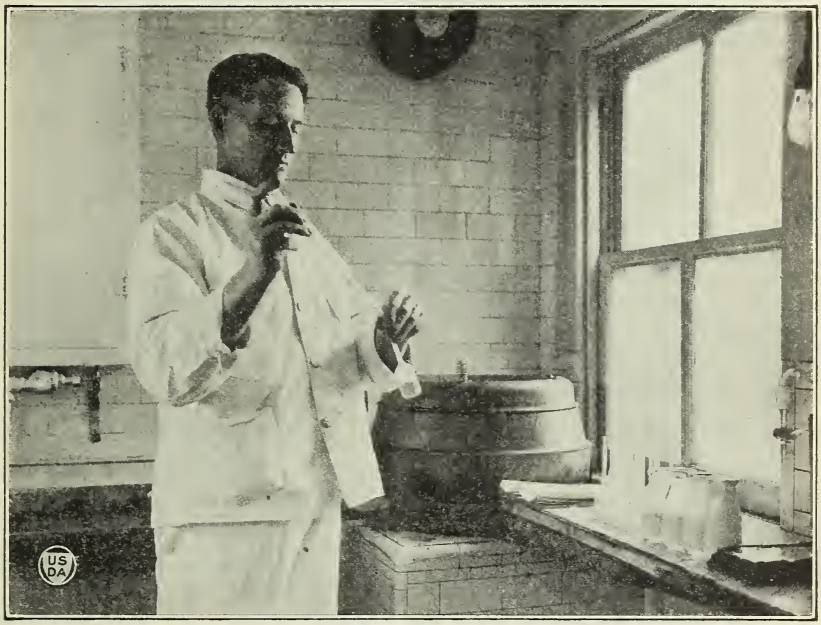

FIGURE 2.—Testing milk for butterfat content

into the weigh can (if one is used), or dump tank, or the filter may be placed at the entrance to the receiving tank. It is important that such a filter be changed often.

RECEIVING MILK FROM TANK CARS AND TANK TRUCKS

During recent years increasingly greater quantities of milk have been transported to the city in tank trucks and tank cars. In a report on the effects of milk-plant arrangement and methods of operation on labor requirements (*7*) it was shown that in plants where milk is received in tanks and there are no cans used for incoming milk to be washed, the whole process of receiving the milk is greatly simplified. Milk received in bulk can be unloaded much more quickly and with fewer men than that received in cans. This is illustrated in Table 1 (*7, p. 8*).

TABLE 1.—*Results obtained from two methods of receiving milk at 115 plants*

Method	Plants	Milk received daily per plant	Help employed per plant			Milk received per—		Time required to receive 100 gallons		Milk weighed at plant	Plants weighing milk
			Men	Time required		Hour	Man-hour				
	Number	*Gallons*	*Number*	*Hours*	*Man-hours*	*Gallons* [1]	*Gallons* [1]	*Minutes* [1]	*Minutes* [2]	*Per cent*	*Per cent*
In cans from trucks	91	7,328	3.9	4.6	19.1	1,565	384	3.8	5.7	63.8	64.8
From tank trucks or tank cars	24	8,102	1.5	4.4	6.2	1,834	1,309	3.3	3.7	38.8	33.3

[1] Weighted average. [2] Average of averages.

Where cans are used, each one must be unloaded from the truck, dumped into the weigh can, and the can washed. Where tank trucks or tank cars are used, the milk is transferred from the tanks to the weigh can or receiving tank by gravity, pump, or air pressure, and no handling of cans is required. Washing the tank in which the milk is received is a comparatively small task.

Other advantages of transporting milk in bulk are that usually it arrives at the plant in better condition, with a rise of only 1° or 2° in temperature and in some cases is fresher than if cans are used. Less floor space is also required at the plant.

Operating methods employed in handling milk in tank cars and trucks are described in another publication (*9*). The principal precautions are to set the tank car or truck so that it will drain empty, wash the valve connection before attaching the milk line, avoid contaminating the milk in operating the stirrer or in drawing samples, and to see that the tank as well as the plant-connecting lines, after being emptied, are thoroughly cleaned and treated to kill bacteria. (Fig. 3.) It is essential to check the contents of tanks by weighing in the milk at the plant.

PASTEURIZING TEMPERATURE AND HOLDING PERIOD

Pasteurization is the process of subjecting every particle of milk to a temperature of not less than 142° F. for 30 minutes and immediately cooling it to 45° or below. In order to insure that all the milk will be heated to the required temperature it may be necessary in some plants to operate the pasteurizer at a slightly higher temperature as a factor of safety. Whether this will be necessary depends somewhat on the heating efficiency of the pasteurizer, the accuracy of its temperature control, and the care with which it is operated. In order that the milk may be made absolutely safe for human consumption, it is essential that every particle be heated to at least 142° and held at that temperature for 30 minutes. Proper pasteurization of milk not only kills all disease-producing bacteria that may be present, but also kills some of the lactic acid-producing bacteria and thus enhances the keeping quality of the milk (*1*).

While it is absolutely essential that the milk be heated to the pasteurizing temperature and held there for 30 minutes, care must be taken that it is not heated too high. If the temperature of the milk is allowed to go much above 142° F., the cream layer may be injured. Experiments have shown that milk may be heated to 143° for 30 minutes with practically no injury to the cream layer. Pasteurizing milk at 145° to 146° for 30 minutes will cause a decrease in cream volume of approximately 8 per cent, and heating to 148° for 30 minutes will result in an even greater decrease (*16, p. 23*).

OPERATION OF THE PASTEURIZING AND COOLING EQUIPMENT[3]

The proper pasteurization of milk is a simple operation and there is little excuse for the poor results obtained at some plants. Such results are usually not the fault of the type of pasteurizer used but are due to faulty operation.

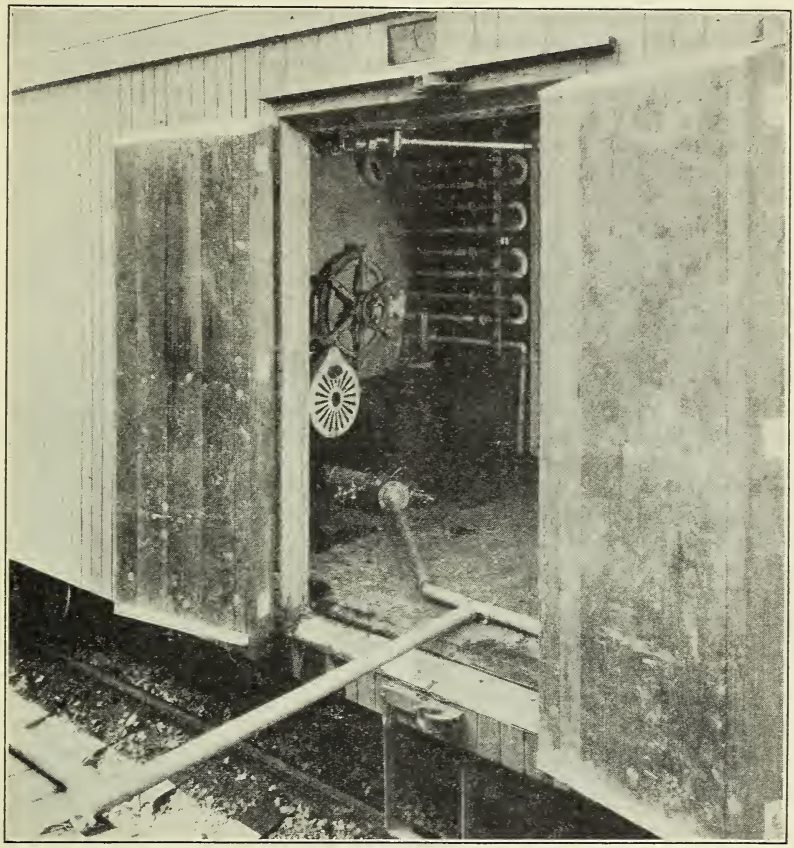

FIGURE 3.—Drawing milk from tank car through sanitary piping which leads to storage tank in plant

Ten causes of poor pasteurizing results at some milk plants are:

(1) Leaky or inaccurate valves, which allow some of the milk to get through the apparatus without being held long enough.
(2) Inaccurate temperature recorder; inaccurate indicating thermometer.
(3) Pipes and pumps not properly cleaned and treated to kill bacteria.
(4) Filler and valves not properly cleaned and treated to kill bacteria.
(5) Pumps and piping not of sanitary construction.
(6) Rushing milk through the apparatus too fast.
(7) Not heating milk to high enough temperature or holding it long enough.
(8) Adding raw milk to pasteurized milk in vat before the pasteurized lot is all drawn out.
(9) Formation of foam in the holder.
(10) "Pockets" in the apparatus which prevent some of the milk from receiving the required heat treatment.

[3] For a description of various types of pasteurizers, see U. S. Dept. Agr. Circ. 99 (*6*).

PASTEURIZING AND COOLING IN PLANTS USING VAT PASTEURIZERS

Vat pasteurizers are usually manually operated and it is therefore important that a competent and reliable man be assigned to the work.

In filling the pasteurizer at very small plants the milk may be poured directly into the pasteurizing vat from the cans, if an efficient strainer is used. It is better practice, however, to pump the milk from a receiving vat or dump tank through an effective strainer or filter to the pasteurizing vat; a gravity flow may be used if the plant is suited to a gravity system. Great care should be taken to flow or pour the milk smoothly into the pasteurizing vat, as excessive splashing will cause foam, which is very undesirable.

As soon as enough milk to cover the lower part of the coil has entered the pasteurizing vat it should be started revolving and circulation of the heating medium begun. It is desirable that the temperature of the heating medium be only a few degrees higher than that to which the milk is to be heated, but it may be necessary, depending upon the efficiency of the equipment and the accuracy of control in each particular plant, to operate the apparatus at a still higher temperature. However, the temperature of the milk should never be allowed to rise more than slightly above the pasteurizing temperature, in order to avoid injury to the cream line, "cooking" of milk on the walls of the vat, possible scorched flavor, and other undesirable consequences.

During the whole process of heating and holding, the cover of the vat should remain tightly closed. When the dial on the temperature recorder indicates that the milk has reached the desired temperature, the circulation of the heating medium should be promptly shut off. The exact temperature at which circulation should be shut off to avoid overheating the milk depends on the individual plant, but usually the circulation should be stopped just before the milk reaches the pasteurizing temperature. The operator, after a little experience, will soon learn to shut off the circulation at exactly the proper time. The coil should then continue to revolve until the temperature of the milk has become uniform in all parts of the vat. This condition may best be determined by the use of indicating thermometers inserted at different points in the vat to supplement the recording thermometer. If the indicating thermometers show that the milk has not been heated enough, circulation of the heating medium should of course be started again, but this rarely happens under an experienced operator. When all the milk is at the pasteurizing temperature, the coil may be stopped and may be kept shut down during the holding period, although some operators prefer to start it again before the end of the holding period to insure complete mixing of the milk and a uniform temperature. Moderate agitation during the holding period seems to have no appreciable effect on the cream volume of the milk.

The outlet valve should never be opened until 30 minutes after the time when the milk reaches the pasteurizing temperature, and no milk should be added to that in the vat. The pasteurizing vat should preferably be emptied in from 15 to 20 minutes after the end of the holding period, so that none of the milk will be held for too long a time. At some plants, after the holding period is completed, the milk is precooled in the vat to a temperature of 115°

to 120° F. by circulating cold water through the coil. When this temperature is reached, the milk should be sent to the cooler. Cooling in the vat to a temperature below 115° is not desirable, as it may injure the cream layer of the milk (*16, p. 9*).

Throughout the entire process of pasteurization the operator should see that there are no leaks at valves or elsewhere in the apparatus. During the heating and holding periods the vat should not be connected with the piping or fittings leading to the cooler, unless the apparatus is equipped with leak-protector valves so that no incompletely pasteurized milk can escape to the cooler.

At many plants the milk is preheated before it enters the pasteurizing vat. In that event it goes from the receiving vat to the preheater, a flash heater that heats the milk to a temperature of approximately 100° F. From the preheater the milk usually passes through

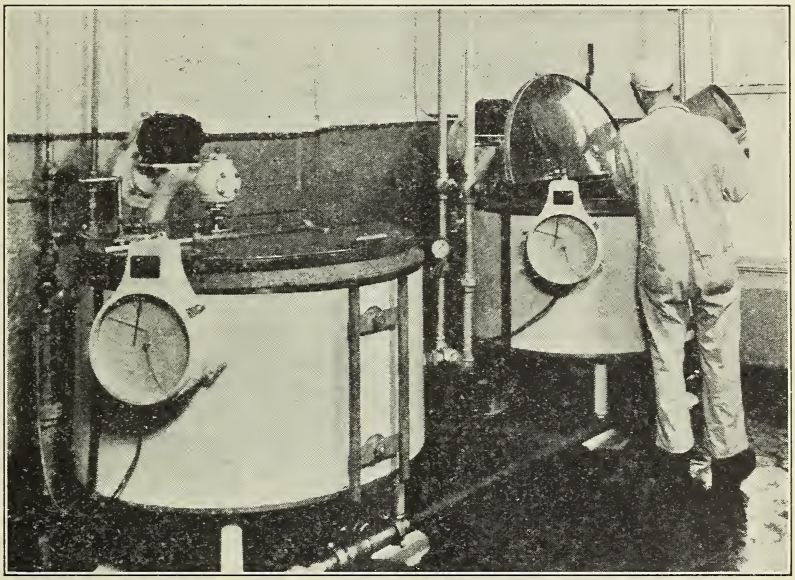

FIGURE 4.—Dumping milk into a tank pasteurizer. Note temperature recorder attached to each pasteurizer

a filter or clarifier into the pasteurizing vat, where the heating process is completed. The milk should be filtered before pasteurization rather than after. Satisfactory results are obtained at many plants by filtering or clarifying the milk before it is preheated.

Where a battery of pasteurizing vats is used, they should be so operated that as soon as one vat is emptied the milk in the next will have been heated and held for 30 minutes and be ready to go over the cooler. Thus, with a battery of three vats the system becomes continuous.

PASTEURIZING AND COOLING IN PLANTS USING TANK PASTEURIZERS

Steam at low pressure is the heating medium used in tank pasteurizers. (Fig. 4.) The steam valve may be "cracked" (turned very slightly) while the tank is being filled in order to take the chill off the walls of the tank. When the tank is about half full, the agitator

should be started. If the agitator has two speeds, it should be run in the low speed at first and changed to the high speed when the tank is full. After the tank has been filled the steam valve should be opened wide enough to maintain a pressure of about 3 pounds in the jacket of the tank; if the jacket is of the open steam-circulating type, the valve should be so adjusted that steam will not blow out through the vapor steam trap. With a little experience the operator will soon learn just how wide the valve should be opened.

The steam should be turned off from the jacket just before the milk reaches the pasteurizing temperature, and practice will soon enable the operator to determine at just what point this should be done. During the holding period the agitator should be run at low speed.

The tank should be emptied within 15 to 20 minutes after the end of the holding period if the milk is sent direct to the cooler, or cold water may be introduced into the jacket of the tank and the milk precooled to a temperature of 115° to 120° F. before it is released to the cooler. Like precooling in vats, the cooling should be completed over a separate cooler, as the cream layer of the milk may be decreased if the entire cooling is done in the tank. Precooling in the tank may lessen the work of cleaning it afterward, as there is less likelihood of milk cooking on its walls than when the hot milk is not precooled. After the holding period the milk should be cooled quickly to 45° or below, with as little agitation as possible. In order to avoid freezing the milk on the coils of the cooler, the temperature and flow of the final cooling medium should be carefully watched and controlled.

As with pasteurizing vats, a battery of three pasteurizing tanks may be used, thus making the system continuous.

In order to increase the capacity of the pasteurizing system, tanks in conjunction with flash heaters are often used as holders. With three or four tanks and a flash heater, the system becomes continuous. The milk is heated to the pasteurizing temperature by the heater and then passes to the tank holders. When the last tank has been filled, the first tank will have been held 30 minutes and emptied and is ready to be filled again. The capacity of such an outfit is considerably greater than that of one in which only tanks are used without the preheater. At some plants equally good results are obtained by preheating to about 100° to 110° F. with a flash heater and completing the heating in the tanks. In that case, the filter or clarifier usually is placed between the preheater and the tank pasteurizers.

PASTEURIZING AND COOLING IN PLANTS USING CONTINUOUS-FLOW PASTEURIZERS

In operating a continuous-flow pasteurizer, which is a system of heaters and holders through which the milk passes in a continuous flow (*6*), it is very important that the milk flow through the apparatus at a uniform speed. Usually the milk is pumped through the apparatus. The milk pump should be so installed and operated that it will deliver a uniform quantity of milk to the pasteurizer at all times. Where holders of the pocket type are used, careful attention must be given to see that the mechanism is working properly; that the valves are opening and closing at the proper time; and that there are no leaks. The milk goes directly from the holder to the cooler.

CONTROL OF THE MILK FLOW

Accurate control of the flow of milk in milk plants, especially where the continuous-flow system of pasteurization is used, is important and requires close attention. It is essential that the flow of milk to or through the different machines or units, such as clarifiers, pasteurizers, holders (of the continuous-flow type), and coolers be so regulated that it will not exceed their capacity, but will be maintained at a uniform speed at all times. Equipment for control of the milk flow should operate automatically so far as possible and should be checked from time to time to insure accuracy. The accuracy of all continuous-flow holders should be checked frequently. Several different tests are used (*6, p. 17*). Automatically operated compartment holders should also be checked often for accuracy. It is essential that the valve on the compartment that has been emptied should be closed tightly before the next lot of heated milk begins to flow in, and that none of the valves leak at any time.

In order to insure the proper holding time in continuous-flow pasteurizers, the milk must flow to the heater at a uniform and predetermined rate of speed. One of the principal factors that affects the flow of milk is variations in the head or depth of milk in the tank which supplies the pump or gravity line to the heater. Whether the milk flows to the heater by gravity or is pumped, some form of float control will help to maintain uniform flow. A device used in many plants consists of a tank in which a constant depth of milk is maintained by a float, and which has an outlet of such size that it will discharge the required amount of milk per hour, either directly to the heater, if gravity flow is used, or to the feed end of the pump, if a pump is used.

The pump should be so designed that its speed can not be changed by the operator, and should be so adjusted that the number of strokes per minute will be uniform at all times. A direct-connected motor-type pump or a pulley-type pump is more easily controlled than a steam pump. Even if a constant head of milk is maintained at the feed end of the pump, and the pump is operated at a constant rate of speed, it can not always be depended on to deliver a uniform flow of milk to the pasteurizer, because the plunger, cylinder, valve, or other parts of the pump may become worn so that the quantity delivered per stroke will not be uniform. It is important, therefore, that the pump be kept in good repair.

In some plants the clarifier is depended upon to control the flow of milk through the various pieces of apparatus in the plant. Of course, where this method of control is used, the clarifier should be operated at a constant speed and the feed of the clarifier, which is controlled by a float, should receive a constant supply of milk. All apparatus to which the milk goes subsequently is so regulated that it will take care of the milk as fast as it comes from the clarifier. If the float in the clarifier is operating accurately, this system should provide a uniform flow of milk to the heater. When equipping new plants considerable attention should be given to properly correlating the capacities of the various machines. For example, the clarifiers, pasteurizers, coolers, and bottle fillers should be of approximately the same capacity. It is especially important that the cooler be large enough to handle the milk at all times as fast as it comes from the pasteurizers and as fast as the bottle fillers will take it away. The

cooler can be slowed down more easily than it can be speeded up. Unless it is of ample capacity, the attendant will be likely to allow the milk to run over or through it too fast when he is rushed, and the milk will not be properly cooled.

Great care should be taken that valves and connections in the milk line do not leak. Leaky valves and joints are common in some milk plants, and result in a very insanitary condition and considerable loss of milk. Preventing milk losses is an important part of the manager's duties, and no pains should be spared to keep all valves and connections in the milk lines tight.

TEMPERATURE CONTROL

One of the most important requirements in properly pasteurizing milk is accurate control of the temperature in heating and holding the milk. Automatic devices that will control the temperature in the pasteurizers and holders very accurately are on the market. Such a device is necessary, because it is difficult and often impossible to regulate the temperature properly by means of hand-operated valves. The temperature controller should be supplied with steam at a constant pressure in order to cause it to operate at constant temperature. Therefore, a steam reducing or equalizing valve should be placed between the boiler and the temperature controller, so that the operation of the controller will not be affected by fluctuations in the steam pressure at the boiler.

Recording thermometers (fig. 4), in addition to the indicating thermometers, should be used at all milk-pasteurizing plants. The recording instruments should be tested frequently for accuracy. In addition to being checked by health officials these instruments should be checked often with an officially calibrated thermometer, by the plant operator. At the beginning of each run, all charts for recording the time and temperature of pasteurization should be set uniformly on the instrument dials, at the correct clock time, in order to determine the time during which the milk is held at the pasteurizing temperature. Where a continuous-flow system is used, the holding time may be checked at the beginning of the run by determining the length of time that elapses from the moment that heated milk first enters the holder until it is first discharged from the holder to the cooler. If the flow of the milk through the apparatus is properly controlled and is maintained at a constant speed, the holding time for all the milk during the entire run will be the same. Where vats are used for heating and holding the milk, the chart of the recording thermometer connected with the cooler will record the temperature to which the milk was cooled and also the time when the holding period ended. Consequently, this chart, together with the chart of the thermometer attached to the pasteurizing vat, will indicate the length of time that the milk was held, provided that both charts were set on the instrument dials at the same time.

There is, however, on the market a device that registers upon the chart of the recording thermometer the instant of opening or closing the outlet valve of the vat or tank, and thus records directly the minimum length of time that the milk is held at the pasteurizing temperature. If the recording thermometer is not equipped with this device, and the milk is not precooled in the vat, it is often difficult to determine from the chart just when the first milk is let out of the vat.

For example, if the thermometer bulb is attached near the bottom of the vat or tank the chart on the temperature recorder would show the pasteurizing temperature for the entire time that the vat or tank was being emptied, in addition to the holding period. If 30 minutes were required to empty the vat, the chart might indicate a 45-minute holding period, although the first milk let out was held only 15 minutes before the outlet valve was opened.

As previously stated, however, the combined records from the charts at the pasteurizing vat and at the cooler, if they are properly set on the dials, will assist in determining the actual holding time.

The charts from the recording instruments constitute a permanent daily record of the pasteurizing process, and besides being necessary for the use of the plant superintendent in checking the operation of the pasteurizing department, they are often valuable in showing health officials how the process was performed.

CLEANING THE PASTEURIZING AND COOLING EQUIPMENT

As soon as the pasteurizing run is completed and all the milk has been emptied from the vat, the cleaning of the pasteurizing equipment should be begun. First the vat and then the rest of the equipment should be thoroughly rinsed with lukewarm water. It is usually desirable to run lukewarm water through the whole system of equipment and piping, from the weigh can and receiving vat through the pasteurizing outfit, over the cooler, and through the bottle filler. As soon as the apparatus has been thoroughly rinsed, the entire system should be cleaned with hot water to which washing powder has been added. Brushes should be used to scrub off all particles of milk or casein adhering to the sides of the vat. Special attention should be paid to scrubbing the coil thoroughly clean each day, otherwise heated milk will cake on the surface of the coil and the work of cleaning the coil will become increasingly difficult. If this cake or "stone" has formed, mineral wool or some similar scouring material is useful in removing it. Thorough daily cleaning of the coil will prevent the cake from forming, and the pasteurizing results will be much more satisfactory.

After the vat, cooler (fig. 5), and other apparatus have been thoroughly cleaned, they should be rinsed with hot water and then thoroughly steamed or treated with a chemical agent to kill the bacteria. Immediately before the milk is started through the system the next day, the entire apparatus should be thoroughly steamed or treated with a chemical agent to kill bacteria.

The directions for cleaning vat pasteurizers may be followed in cleaning metal-lined tank pasteurizers and holders.

Enamel or glass lined tanks are cleaned in the same way except that special care should be used not to injure the enamel. Washing powders containing acid or caustic alkalies, and also steel wool or wire brushes should be avoided, as their use might injure the enamel. A soft bristle brush with caustic-free carbonate cleansers may be used without injury. Best results are obtained by thorough scrubbing and by avoiding a prolonged soaking period. After thorough cleaning, the tank should be treated with either steam or a chemical agent to kill bacteria.

LABOR REQUIRED FOR PASTEURIZING AND FOR CLEANING PASTEURIZING EQUIPMENT

In a study made at 112 city milk plants of various sizes (7), the amount of milk pasteurized per man-hour of labor for plants of various sizes was determined. These results are summarized in Table 2.

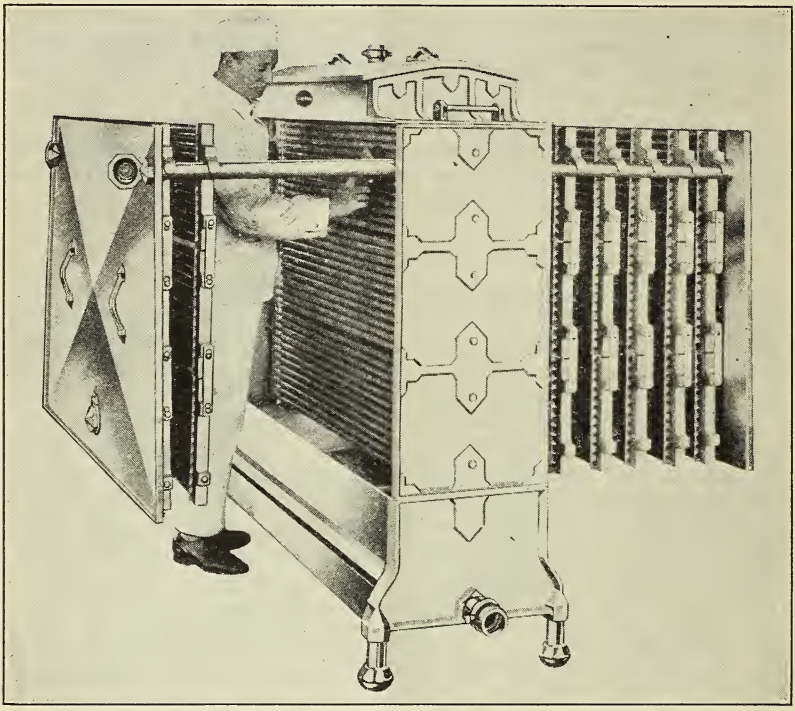

FIGURE 5.—Cleaning a tubular cooler of the cabinet type

TABLE 2.—*Relation between the size of plant and labor requirements for pasteurizing and cooling the milk and cleaning the equipment at 112 plants*

Milk pasteurized daily (gallons)	Milk pasteurized and cooled per man-hour		Labor required per day for cleaning pasteurizing equipment
	Excluding labor for cleaning equipment	Including labor for cleaning equipment	
	Gallons	*Gallons*	*Man-hours*
3,000 or less	439	246	3.7
3,001 to 5,000	690	341	5.0
5,001 to 10,000	982	434	9.3
10,001 to 15,000	1,290	476	17.3
Over 15,000	1,588	450	24.4

These results show that labor for pasteurizing can be used more economically in large plants than in small plants. In plants of all sizes at least one man must be detailed to the pasteurizing department when it is in operation. Even in very small plants one man must

spend practically all his time at the pasteurizer during the pasteurizing period to see that the apparatus is operating properly, to watch the temperatures, and to operate the valves when necessary. Since large plants usually require not more than two men and in many instances only one man to operate the pasteurizing department, the quantity of milk pasteurized per man-hour is much greater than in small plants.

On the other hand, the number of man-hours of labor used for cleaning the pasteurizing equipment is greater in the larger plants than in the smaller plants. The more economical showing at small plants in this respect, however, is partly due to the fact that the man who operates the pasteurizing equipment usually starts cleaning during the last part of the day's run, so that some of the time spent in cleaning work is not actually charged to cleaning. Large plants doubtless keep closer account of the time spent in cleaning by employees working in the pasteurizing department. Many large plants find it desirable and economical to employ a separate crew of men whose sole duty is to clean the pasteurizing equipment after the plant is shut down. Where a separate cleaning crew is employed this important task is not so likely to be slighted or rushed, to the detriment of the product, as where the pasteurizing crew must clean the equipment before they can complete their day's work. Furthermore, this system permits the pasteurizing department to be run during the full working day.

When the total amount of labor used for pasteurizing the milk and cleaning the equipment is considered (Table 2), the difference between the quantity of milk pasteurized per man-hour at the small plants and at the large ones is not so great as for pasteurizing alone, but is still decidedly in favor of the larger plants.

BOTTLING AND CAPPING

As soon as the milk has been pasteurized and cooled, it should be put immediately into clean, cool bottles. Where a continuous-flow pasteurization system is used, or where a battery of tanks or vats is operated as a continuous system, the process of bottling and capping can be carried on at the same time as pasteurization. Therefore the capacity of the bottle fillers should be approximately the same as that of the pasteurizing outfit. In medium-sized and small plants the pasteurizing and bottling capacity should be such that the pasteurizing and bottling may be done in four or five hours. Then the same set of men can be used during the rest of the day for other work, such as receiving and weighing the milk and washing the bottles and cans. In small plants where only one pasteurizing vat is used, two men can weigh and dump the milk as it is received, pasteurize it, run it over the cooler, and do the filling and capping.

The bottling and capping should be done by automatic machines. (Fig. 6.)

CLEANING BOTTLES

The milk bottles should be cleaned in ample time to be thoroughly cool before they are filled with milk. If the bottles are not cool, the temperature of the milk put into them is raised. This means a waste of refrigeration, and possibly increased development of bacteria. At many plants bottles are washed in the morning and filled in the

afternoon. Great care should be taken to see that the bottle washer is always in good working order, for if the bottles are not properly cleaned and treated to kill bacteria the pasteurized milk will be contaminated.

If a brush washer (*6, p. 25*) is used, the brushes should be changed before they become worn, and the wash water should be changed occasionally during the day. Great care must be taken to see that the rinsing and steaming device of the machine is in good working order at all times. Each bottle should receive first a strong jet of rinsing

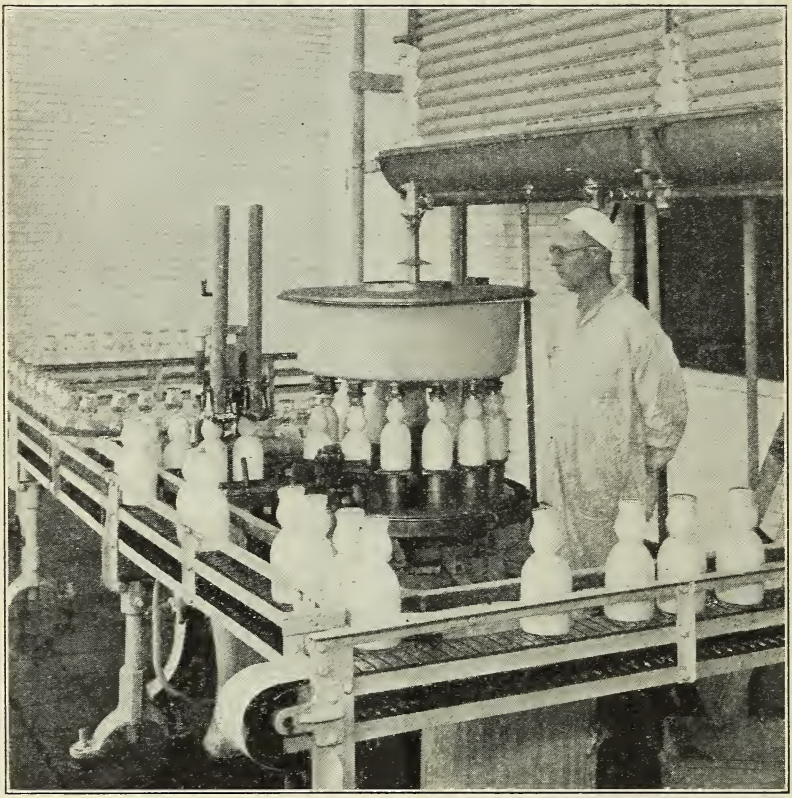

FIGURE 6.—Bottling milk with an automatic rotary capper and filler

water and then a spray of scalding hot water or a jet of steam for at least 45 seconds. The jet openings should be kept free from obstructions. After the bottles are washed they should be kept in a cool, clean place until wanted for filling. It is a good plan to use special cases at the washer and transfer the bottles, after they are washed and steamed, to clean, dry cases. If the same cases that are used in the washer are also used to store the bottles, there may be a constant drip from each case into the case below; and unless the bottles are inverted in the cases, contamination may result; furthermore, these cases soon become soggy and are often not suitable for use on delivery routes.

Where an in-the-case pressure washer (*6, p. 25*) is used, care must be taken to see that all the jet openings are free and working at all times and that the solutions in the various tanks are kept at the proper strengths and temperatures. The temperature of the water in the first tank should not be so high that bottles will be cracked. The temperature of the water in each succeeding tank should be gradually increased and the water in the final tank should be near the boiling point. In small machines of this type with only two or three tanks, the increase in temperature of the water in the various tanks is necessarily more sudden than in the larger machines with four or more tanks.

Medium-sized and large plants now generally use bottle washers of the soaker type (*6, p. 26*), which wash the bottles after they have been removed from the cases. In large plants one man is generally required to care for these machines to see that they are in proper working order, well lubricated, and that the solutions in the various tanks are of the proper strength and at the right temperatures. In washers of this type, after the bottles have been cleaned they are rinsed several times in waters of decreasing temperature, which cool them so that they can be filled immediately. From the washer the bottles pass on automatic conveyors to the fillers. Less labor is required and fewer bottles are broken under this system of washing and filling than under the indirect system, under which the bottles are washed in an in-the-case washer and then stacked to be filled later (*7, p. 16; 5, p. 16*).

Although the total labor requirements are greater under the indirect system of washing and filling, some small plants may find this system more advantageous than the direct, as the initial investment is smaller and the same men who wash and stack the bottles may fill them later. Even in small plants, however, at least two men are generally required to operate an indirect or in-the-case washer, stack the cases to cool the bottles, and later transfer the bottles to the filler and operate the filler; whereas with some of the smaller soaker-type machines only two men are required to wash and fill the bottles, one at the washer and one at the filler, and the time required is much less than under the indirect system. In deciding which system is more economical for a particular plant, the initial cost of the two types of washers with the resulting overhead—interest on the investment, depreciation, and repairs—must be considered, as well as the comparative costs for labor, steam, and power for operation. The soaker-type washers often have a variable speed adjustment and can be timed to synchronize with one or two fillers, depending on the capacity desired. Both small and large machines of this type are available.

After the bottles are washed, they should be treated with steam, hot water, or chemicals to kill bacteria. The large machines are usually equipped to give the bottles chemical treatment, which properly applied gives very satisfactory results. Also, fewer bottles are broken in plants where this treatment is used than in plants where steam or hot water is used, as the glass is not subjected to such sudden changes in temperature (*5, p. 18*).

Bacteriological tests on the bottles as they come from the washer should be made frequently to check up on the efficiency of the machine.

INSPECTING BOTTLES

While mechanical bottle washers generally clean the bottles satisfactorily, there are often some bottles that can not be thoroughly cleaned in the washer without special attention. Bottles that come unwashed from the exchange or that have stood for several days, and in which the casein of the milk has dried, will sometimes pass through the machines without being properly cleaned. It is usually necessary to cull out these very dirty bottles and scrub them with a brush before they are sent through the washing machine. A good plan is to soak them overnight in a solution of washing powder. For scrubbing such bottles it is advisable to have, besides the automatic washing machine, a small mechanical brush washer (without rinsing apparatus) in which the bottles are washed by hand.

Besides culling out very dirty bottles before they enter the machine, it is necessary to inspect all bottles after they leave the machine. It is also important to inspect all bottles after they are filled. Delivering milk in a dirty bottle is a serious matter from a public-health standpoint, and may also cause the loss of the customer. In large plants inspectors are often so placed that the bottles are inspected as they leave the bottle washer, again before they are filled, and finally after they are filled; and even then it is possible for some dirty bottles to get out to the trade. Improperly cleaned bottles which have passed the inspector at the bottle washer can usually be detected by the man at the filler, however, as any dirt specks will usually show up more plainly after the bottle is filled with milk than before.

WASHING CANS

Washing cans, while only a small part of the daily routine at a milk plant, is very important, because the quality of the milk depends on the care with which this work is done. Many different methods are used in caring for the emptied cans and there are several different types of can-washing machines on the market. However, in the use of all efficient machines the principal object is thorough cleansing with a solution of washing powder and water, followed by rinsing, steaming, and rapid drying. After the cans are dry they should be covered and kept from contamination. The large machines are fitted with powerful pumps, and while the cans, inverted, are being run through the machine, sprays of a solution of washing powder and water, of rinse water, of hot water, and of steam are successively forced into the cans under considerable pressure. The cans are dried in the same machine by a blast of hot air. When they leave the machine they should be clean, dry, and odorless.

Very satisfactory results can be obtained at small plants by washing the cans thoroughly with a hand brush and water to which washing powder has been added. The cans should then be rinsed and steamed with a jet of live steam for at least 45 seconds. After steaming, the cans should be allowed to stand for a few seconds until thoroughly dry. At small plants they may be dried on a rack. This would require an extra set of cans, as the producer or truckman must have his cans immediately, and such a method would not be practical for large plants.

Steaming and drying the cans is very important. They should be steamed until they are too hot to handle with the bare hands and will become dry in a few seconds. Not only does drying leave the can in a

good sanitary condition, but it helps to prevent rusting and to prolong the life of the can. The covers should be thoroughly cleaned and steamed before being returned to the cans. Many large plants use machines that automatically put the covers on the cans after they have been washed, steamed, and dried.

MILK-PLANT SANITATION

The importance of cleanliness in handling milk can not be overestimated. The plant operator is responsible for the quality of the milk after it is received at the city plant, and he must keep the plant and equipment in a sanitary condition at all times in order to be able to put out a high-quality product. Every surface with which the milk comes in contact must be thoroughly cleaned and treated with steam or chemicals (where chemicals are permitted) in order to kill bacteria. The equipment must be kept in good repair and rough or rusty surfaces with which the milk may come in contact should be eliminated, as they are difficult to keep clean and free from bacteria.

On arrival at the plant, the milk should either be put in a cold place or immediately started on its course through the plant. The cans may be put into the refrigerator or have ice packed around them, or the milk may be stored in tanks provided for the purpose. These tanks should be in a cold room or be insulated or jacketed, so that the milk may be kept at a low temperature until it is passed through the plant. The milk should be strained or run through a clarifier or a filter which will remove the greater portion of any dirt. It should be filtered before pasteurization and not after. At small plants satisfactory results can be obtained with a simple strainer or filter of cheesecloth and cotton. A rack or holder is used to support the filter; the cheesecloth is first laid on one of the holders and then some sterilized cotton is placed on the cheesecloth and the cloth is folded over it. Another holder is then placed over the whole. The filter is attached either to the dumping device or to the receiving tank. Usually it will be necessary to change the filter during the day (depending on the quantity of milk handled), as the cotton will become clogged after continuous use; also, if care is not taken, the cotton may get out of place so that some of the milk will pass through the filter cloth without going through the cotton. The cheesecloth, if used a second time, must be thoroughly washed and steamed after each use, and kept in a clean place. It is more satisfactory, however, to use it for one day's run only. The cotton will of course be thrown away after being used once.

In passing through the various pieces of apparatus the milk should be exposed to the air as little as possible; and after pasteurization, cooling, and bottling it should be kept in the milk-storage room until taken to the delivery wagons. It is essential that the milk be cooled to 45° F. or below and held there until delivered to the consumer. In the milk-storage room a temperature of 40° or below should be maintained.

As soon as all of the milk is bottled, all parts of the milk-handling apparatus should be cleaned thoroughly by first rinsing in cool or tepid water, then washing with hot water to which washing powder has been added, and finally treating with boiling hot water or steam or a chemical agent. After the milk has passed through the apparatus it is a good plan to pump cool water through the entire system first,

and then hot water to which washing powder has been added. The pumps and pipes can be rinsed immediately after use, by pumping water through them. They should then be taken down and thoroughly washed, and this can be done easily if there are numerous hand couplings in the pipes. (Fig. 7.) After being washed and rinsed the pumps and pipes should be treated with steam, water at or near boiling temperature, or a chemical agent (p. 23).

Cleaning and steaming the milk piping and pumps are often neglected. While it is sometimes possible to clean the pipes satisfactorily by pumping cleaning solutions through them and following this with thorough rinsing and steaming, usually this is not sufficient. It

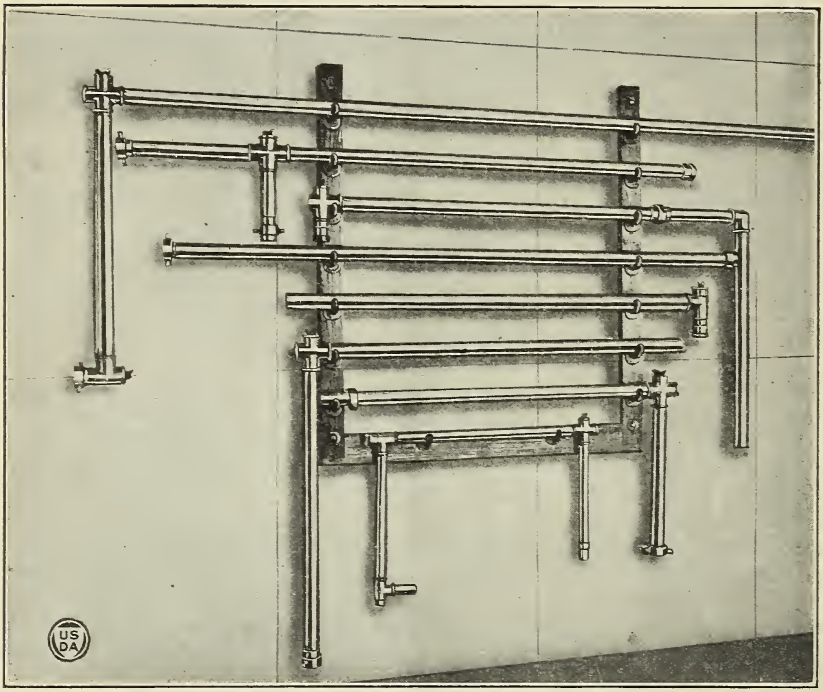

FIGURE 7.—Sanitary milk piping disconnected, washed, and steamed

is much more satisfactory to take down the piping and clean it thoroughly every day. At many plants complaints are received about the quality of the milk, that the milk turns sour quickly, etc., and the operator is often at a loss to know what the trouble is, as he has been careful with the temperatures used in pasteurization and the milk has been kept cold after pasteurization. Often the trouble is found to be with the milk pipes, joints, and pumps. If the pipes are not thoroughly cleaned and steamed each day, filth and dirt will soon collect at joints and elsewhere, and the milk passing through such apparatus will be badly contaminated and will be of poor quality. Great care should be taken in cleaning the pasteurizing outfit. This should be rinsed immediately after being used, and then thoroughly cleaned and finally rinsed and steamed (p. 15).

Flies should be rigorously excluded. All windows and doors should be well screened. The door should open outward, and revolving fans placed near it and blowing toward it will often keep many flies from entering the plant by providing a constant breeze which forces the flies out as the doors are opened. Fans placed near milk apparatus, such as open coolers, also tend to keep flies away from the apparatus and out of the milk. Good ventilation is essential (*4, p. 33*).

Keeping a milk plant clean is a simple matter for a person who bears in mind the fundamentals of sanitation and has a fair idea of bacteriological principles. Everything with which the milk comes in contact should be kept clean from a bacteriological standpoint. Milk should be exposed to the air as little as possible; it should be pasteurized at 142° to 145° F. for 30 minutes, cooled to 45°, and kept at 45° or below until delivered.

Special attention should also be given to cleanliness of the delivery outfit. Many dealers naturally take great pride in the appearance and cleanliness of their plants, but customers have an opportunity to see the delivery outfits every day, while only a few ever visit the plants. The horses should be kept in good condition and well groomed, the harnesses clean and well oiled, and wagons and trucks well painted and washed. Drivers should be clean, neatly dressed, courteous, and obliging. Many a good customer has been lost by a discourteous driver, while many a new one has been gained by a polite and obliging driver. A uniform or white suit adds much to the driver's appearance. Where cash sales are made in office buildings or other places in which the customer deals directly with the driver, a clean white suit is especially desirable.

TREATING EQUIPMENT TO KILL BACTERIA

After the milk-handling equipment has been thoroughly cleaned with a solution of washing powder and scrubbed with brushes whenever necessary, it must be thoroughly rinsed and treated with heat or a chemical agent (*10, p. 8*) to kill the bacteria.

HEAT TREATMENT

Hot water or steam, thoroughly applied, will kill most of the bacteria on the equipment after it has been properly cleaned. Steam, however, is effective only when it can be somewhat confined. Open surfaces, such as surface coolers, are very difficult to treat properly with steam from a steam hose, because not enough heat can be applied to kill the bacteria on account of absorption of heat by the surrounding air. For such surfaces as open coolers, hot water is more effective than steam. Water at the boiling point or as near it as possible should be used, otherwise the treatment will not be effective. Of course, the first water will cool off when it comes in contact with the cooler surface, and the surface to be treated should be flushed for not less than five minutes with water at a temperature of at least 165° F. Thermometers or temperature recorders may be used to check the temperature of the water. For closed surfaces, such as pipes, internal-tubular heaters, holders, and coolers, steam may be applied and confined in the apparatus with very satisfactory results. Cans can best be treated by the generous use of steam.

CHEMICAL TREATMENT

Chemical treatment of milk-handling equipment has become very common during recent years. Chlorine as a gas or as a compound is the chemical used, and may be purchased in such forms as sodium hypochlorite, calcium hypochlorite, and compounds containing chloramines. These compounds may be purchased under various trade names. Before any chemical treatment is used it should be ascertained whether the local health authorities recognize and permit its use.

Small equipment, such as fittings, pump parts, filter parts, etc., can best be treated by immersing them in a tank containing the solution. Each piece of apparatus should be thoroughly immersed and should remain in the solution for at least two minutes. Large equipment, such as open coolers, vats, etc., can best be treated by spraying. The sprayer should be of the pressure type, and the entire surface to to be treated should be covered with a fine spray. The solution applied as a spray should be about double the strength of that in which the apparatus is immersed.

Homemade chlorine compounds usually cost less than those purchased. However, some labor is saved by using the commercial solutions, as no stock solution need be prepared and their strength is usually more uniform. Directions for making calcium hypochlorite and sodium hypochlorite solutions may be obtained from the Bureau of Dairy Industry.

Very satisfactory results are obtained with the chemical treatment of bottles after they have been thoroughly cleaned and rinsed. The solution with which they are treated must be kept at the proper strength. Its available chlorine content should be approximately 50 parts of chlorine per million parts of water. On the large soaker-type bottle washers chlorine gas may be used to advantage, the gas being fed automatically to the treating solution. Where this system is operating properly, a solution of the proper strength can be depended on to give good results.

When chemical solutions are used for the treatment of dairy apparatus or utensils proper care should be taken to thoroughly drain off all solution after treatment.

MILK-BOTTLE LOSSES

Replacement of lost and broken milk bottles is one of the heavy costs in handling and distributing market milk. Nearly $15,000,000 is spent annually by the milk dealers of the United States for milk and cream bottles, most of which go to replace bottles that have been lost or broken. The records of 76 milk dealers in various cities showed that the life of the milk bottle ranged from 6 to 91 trips; the average was 37.32 trips, while the most common figures given ranged between 20 and 30 trips.

Many bottles are broken in the plant and approximately one-third of the loss is due to this factor, but considerable progress has been made in reducing this loss, both by more efficient arrangement of plants and equipment (*5*) and by impressing on workmen the importance of handling the bottles carefully. Some dealers keep daily records of the amount of glass broken in the plant, and these tend to make the men more careful in handling the bottles.

It is important that the bottle crates or cases be kept in good repair and hold the bottles firmly, especially where the cases are transferred in the plant over gravity conveyors.

Every milk plant should have a system of checking the drivers on the number of bottles brought back each day.[4] Losses will usually be much greater in plants where no record of the number returned by each driver is kept, even though no commission is paid for returned bottles by plants keeping records.

Cooperation of all dealers in a particular locality is necessary for satisfactory results in reducing losses of bottles.

Some of the methods being used in various localities are:

(1) A charge is made for all bottles sold to stores. One of the principal points of loss is stores where no charge is made for the bottles. If there is no incentive for the customers of the store to return the empty bottles, the customers are not likely to do so. Many consumers are not properly informed of the value of the milk bottles, and do not realize that they are the property of the dealer. They will often throw the bottles into the refuse can, break them, or otherwise destroy them. Where the same type of bottle is used for both store trade and family trade, a ticket may be given to the store customer when he pays for the bottle and the amount he pays is returned upon the surrender of the ticket and a bottle. If an empty bottle is surrendered when a bottle of milk is taken away, no ticket or payment is required. In many localities a special bottle is used for sales at stores. For these bottles a price is charged and no ticket is necessary, as such bottles may be redeemed at the store for the price charged at any time. The use of the store bottle greatly reduces the loss of milk bottles. The number of bottles handled by the exchange in one city was reduced more than 50 per cent after the use of the special store bottle was adopted. If the use of the special store bottle is to be successful, all dealers in a city must agree to charge the same price for the bottles delivered to stores and to live strictly up to the agreement.

(2) A charge is made for all bottles delivered to family trade and the driver is usually held responsible for all bottles which he takes out on his route and is charged for any shortage. The driver in turn is permitted to charge his customers for bottles not returned to him if he considers this advisable. This system naturally gives the driver an incentive to get in all the bottles possible. He uses his own judgment in charging his customers for shortage of bottles. Generally this is not necessary, as by impressing upon the customers the fact that he himself is charged for all shortages he can usually persuade the customers to return the bottles.

In some places a modification of this system is used, the dealer also giving the driver credit for stray bottles from other dealers, and using all bottles returned, including strays. Usually there is a limit to the number of extra bottles that will be paid for, and any returned over this limit are credited to the driver to take care of future shortages. While the system of using all bottles, including strays, is not to be recommended, considerable labor in the plant may be saved by this system, as no sorting is required. In a city where this system of pooling bottles was adopted, one dealer operating about 80 routes

[4] See Forms 8 and 9.

was enabled to dispense with three men who had formerly been employed in sorting out stray bottles. Before such a system can be employed in any city, however, it is usually necessary for all of the dealers to cooperate, and if there is a local regulation forbidding the use of stray bottles, to get this regulation suspended. One of the principal objections to the use of this system is that it encourages the drivers to take bottles belonging to drivers for other plants. Furthermore it is often difficult to get all of the dealers in a locality to cooperate in such a plan.

(3) Route drivers are paid a commission based on the number of bottles returned. There are various methods of basing such a system, but one of the most common is to pay a certain amount for each bottle returned daily in excess of a certain percentage (as 90 per cent) of all bottles taken out on that day. Usually an equal amount is deducted from the driver's commission for each bottle that he is short at the end of the day, up to 90 per cent of the number charged to him.

(4) By bringing to the attention of consumers the value of milk bottles and the importance of returning them regularly many dealers have reduced their bottle losses considerably. The following notice which one dealer distributes to his customers calls their attention to the importance of returning the bottles:

PLEASE PUT OUT ALL
EMPTY MILK BOTTLES
EACH EVENING

I am delivering more full bottles than the empties returned.

I am held responsible for all BOTTLES SHORT.

PLEASE HELP ME TO STOP THIS LOSS

Your Milkman.

(5) Dealers in many localities establish milk-bottle exchanges to reduce the loss from stolen or misplaced bottles. These exchanges operate in many of the larger cities and serve as clearing houses. Stray bottles collected by route men are sorted and sent to the exchange, where they are resorted, and in many cases, washed. Usually from one-fourth to 1 cent per bottle is paid to the dealer from whom the stray bottles are received, and he is charged from 1 to 2 cents for each bottle returned to him. Some exchanges do not pay the dealer for the stray bottles he turns in. Bottles brought in by junk men and other collectors are paid for at from 1 to 2 cents each. Many bottles are often reclaimed from the city dumps. In one large city the exchange receives and returns to the owners more than 1,000,000 bottles per week. About one-third of these strays are salvaged by junkmen and other collectors, and many of these strays are gathered from the city dumps. Such bottles are difficult to clean, and if not washed at the exchange, should receive special attention at the city plant (p. 20).

Some exchanges make a small profit, but their object is not to make a profit but to assist in getting bottles back to their owners. Usually the exchange is owned by the dealers, and when the receipts are much greater than the expenses for a continued period of time the surplus is divided among the dealers according to the amount of business done with the exchange.

(6) Using a single-service container for milk, of course, would eliminate the loss of bottles. Such containers have been tried in several instances and are at present in use in some localities, especially for store trade. This system eliminates the collection and washing of bottles, and requires less space on delivery wagons and in the milk-storage room of the plants. The containers are convenient for the stores, which do not have to bother with returned bottles.

At the 1932 cost of glass bottles and the cost of collecting and washing, as compared with the cost of single-service bottles, the single-service container is not able to compete successfully in cost with the glass bottle, even though the life of the glass bottle is only about 30 trips. Furthermore, the single-service containers do not, as a rule, permit the consumer to see the cream or to detect the presence of sediment in the milk. As containers for milk and buttermilk handled through stores they have many advantages, but as yet they have not been generally adopted for use in delivery to family trade.

GOODS RETURNED FROM DELIVERY ROUTES

Another source of loss and expense in the milk business is the large amount of goods returned from delivery routes and the uneconomical disposition of such goods. Of course, it is desirable that the driver keep his returns as low as possible and at the same time have enough goods to supply his customers. It is sometimes difficult for him to figure closely enough and he has to carry considerable extra milk which may have to be returned. He should, however, make a special effort to figure his needs as closely as possible.

The figures in Table 3 were obtained from a dealer operating 25 routes, and show the quantities of various goods returned, expressed in percentage of those taken out.

TABLE 3.—*Quantities of various goods returned at a representative plant with 25 routes, in percentage of goods taken out*

Goods	Goods returned		
	Total, year	Month of October	One Monday in October
	Per cent	*Per cent*	*Per cent*
Gallons milk (bulk)	5.0	2.0	4.5
Quarts milk	4.3	4.0	4.5
Pints milk	5.2	6.0	7.5
Half pints milk	3.1	4.0	7.0
Quarts certified milk	6.4	6.0	6.2
Quarts buttermilk	20.0	22.0	26.0
Gallons cream	6.6	10.0	12.0
Quarts cream	4.0	3.0	6.3
Pints cream	16.0	16.0	20.0
Half pints cream	8.8	9.0	11.0
Half pints whipping cream	25.0	23.0	23.2

Among the methods used to keep the volume of returned goods as low as possible are:

(1) Using the quantity of goods returned by the route salesman as one of the points on which his commission is based. This, however, should be counterbalanced by a commission on sales, so that there will be an incentive for the driver to take out enough goods to supply his customers and to make extra sales.

(2) Giving prizes each month to drivers who return the least goods during the month.

(3) Requiring drivers to pay 1 cent per bottle for all goods returned above 6 per cent of those taken out.

Among the most common methods of disposing of returned goods are: Selling them the same day for cash at the plant or for special orders; selling them to peddlers the same day; selling them on the wholesale routes the next day; selling them on the retail routes the next day; separating and selling the cream to the trade the next day; separating and selling the cream to ice-cream dealers or creameries or disposing of it through the butter, ice-cream, and cheese departments of the plant; selling milk to cottage-cheese dealers; using them in the manufacture of casein, milk sugar, albumen, etc.; using them in the manufacture of buttermilk; and using them in the manufacture of sour cream.

Each dealer has to study his own conditions, since the best method for one dealer may not be suitable for another. Most dealers, however, seem to favor dumping all returns and disposing of the cream for butter and ice-cream purposes. A second grade of buttermilk obtained by making butter from this cream can also be disposed of to bakeries. In this way returns are handled at small expense, and the danger of old milk going out to the trade from this source is eliminated. Using returned milk the next day on delivery wagons should be discouraged and is prohibited by the health departments of many localities.

DISPOSAL OF SURPLUS MILK

Although various systems of buying milk have been worked out (pp. 4 and 5), whereby the prices paid have a tendency to induce producers to adjust their production to the local demands for market milk and thus to reduce the surplus received, surplus milk and its economical disposal is nevertheless an important problem for milk-plant managers. Each milk-plant operator must determine for himself how to dispose of a surplus to best advantage in his particular locality. Market demands and prices are, of course, the important factors in determining what products can be manufactured most advantageously from the milk that can not be disposed of at market-milk prices.

The following calculations illustrate how the returns may be figured on various products that can be made from surplus milk. The values here attached to the various products are arbitrary, and the actual prices will depend, of course, on conditions and locality. The following arbitrary values are used:

Butter	per pound	$0.40
Cottage cheese	do	.05
Sweet cream	per gallon	1.00
Churned buttermilk	do	.15
Cultured buttermilk	do	.20

Value of products from 100 pounds of surplus milk, at assumed prices

Butter, cottage cheese, and churned buttermilk:	
The cream from 100 pounds of 4 per cent milk will make approximately 4.75 pounds of butter, at 40 cents	$1.90
And 1 gallon of churned buttermilk, at 15 cents	.15
The skim milk will produce approximately 11 pounds of cottage cheese, at 5 cents	.55
	2.60
Sweet cream and cottage cheese:	
100 pounds of 4 per cent milk will make approximately 2.4 gallons of 20 per cent cream, at $1	2.40
And approximately 11 pounds of cottage cheese, at 5 cents	.55
	2.95
Butter and cultured buttermilk:	
100 pounds of 4 per cent milk will make approximately 4.75 pounds of butter, at 40 cents	1.90
And approximately 10 gallons of cultured buttermilk, at 20 cents	2.00
	3.90
Sweet cream and cultured buttermilk:	
100 pounds of 4 per cent milk will make approximately 2.4 gallons of 20 per cent cream, at $1	2.40
And approximately 9 gallons of cultured buttermilk, at 20 cents	1.80
	4.20

Thus, at the prices given, it would be more profitable for the milk dealer to separate the surplus milk and sell the sweet cream and make cultured buttermilk from the skim milk. As stated, however, these figures are given merely for illustration; the cost of manufacture, market demand, and the prices that can be procured for the products must be considered in each case. Such illustrations will assist a dealer in determining what prices he can afford to charge for certain products as compared with prices of other products, as well as in determining what products can be made most advantageously from his surplus milk. The market for cottage cheese is often limited and irregular. Usually there is a good demand for good butter, and many plants are able to make a considerable number of cash sales of butter and buttermilk at the plant as well as deliver it on the routes to their regular trade. Whether sweet cream can be disposed of readily depends on the locality.

Some dealers who have a large surplus manufacture it into less perishable products, such as condensed and powdered milk, casein, etc., but, of course, this practice would not be practicable for a small plant. In the case of all products the relative cost of manufacture and marketing must be considered.

MANUFACTURE OF BY-PRODUCTS

A milk-plant operator should be familiar with the manufacture of the ordinary by-products.

Directions on the manufacture of cottage cheese are presented in Miscellaneous Publication 119 (*18*).

One of the most economical ways of disposing of surplus milk is by the sale of cultured buttermilk made from the skim milk. Information on this subject is given in Department Bulletin 319 (*13*).

Directions for making Neufchâtel and cream cheese are given in Department Bulletin 669 (*11*), and for the manufacture of Camembert cheese in Department Bulletin 1171 (*12*). Information on the manufacture of condensed and evaporated milk is given in a mimeographed circular by the Bureau of Dairy Industry (B. D. I. M. 548), entitled "The Manufacture of Condensed and Evaporated Milk."

SHRINKAGE IN HANDLING MILK AT PLANTS

Shrinkage of milk in handling is an important item and should be kept as low as possible. Table 4 gives the shrinkage for a series of days at three plants.

TABLE 4.—*Shrinkage of milk at three city plants*

Plant	Daily receipts at plant	Quantity bottled	Daily loss	
	Gallons	*Gallons*	*Gallons*	*Per cent*
No. 1	1,221	1,184	37	3.0
	1,000	976	24	2.4
	1,200	1,162	38	3.2
	1,100	1,071	29	2.6
Average	1,130	1,098	32	2.8
No. 2	1,324	1,299	25	1.9
	1,295	1,274	21	1.6
	1,492	1,468	24	1.6
	1,395	1,385	10	.7
Average	1,376	1,356	20	1.4
No. 3	1,049	1,004	45	4.3
	1,021	979	42	4.1
	1,087	1,046	41	3.8
Average	1,052	1,009	43	4.1

In a special study made by the writer at plant No. 1 the amount of shrinkage of milk was determined for a period of 21 consecutive days. The average daily loss was 3 per cent of the quantity handled. A special effort was then made to determine the sources of avoidable loss and to reduce the loss as much as possible. After systematic efforts to reduce the losses were made and a regular system of checking the losses was put into practice, the shrinkage was reduced to less than one-half the former quantity, and for 16 consecutive days the average daily loss was 1.48 per cent, ranging from 0.9 to 2.2 per cent of the quantity handled.

While the amount of shrinkage will differ at different plants, plants which are well arranged and equipped and efficiently operated will usually keep it down to about 1 per cent of the quantity of milk handled, or less.

CAUSES OF SHRINKAGE

Losses from shrinkage and milk shortage in the plant are largely due to the following causes: Careless handling of cans in transferring from cars or trucks and in dumping; incomplete draining of cans; leaky or battered apparatus; losses at the filler caused by fillers being out of repair, by leaky or improperly adjusted valves, carelessness in handling bottles, breakage of bottles, etc.; carelessness in handling full cases of milk, thus breaking the bottles; loss from milk left in the pasteurizer, pipes, pumps, tanks, or other apparatus; evaporation and mechanical losses in pasteurizing, separating, homogenizing, and clarifying the milk; loss by transferring milk and cream from bottles to

cans, as in handling milk and cream returned from the routes; shrinkage in cooling milk; breakage of bottles in transferring cases on conveyors, due to poorly constructed cases or to improperly arranged conveyors.

If the milk is weighed at the plant, the first two causes listed would not result in loss of milk to the dealer but the producer would not receive credit for all the milk sent in. There is necessarily a certain amount of shrinkage in transferring milk from cans to bottles and in the processes of pasteurizing and bottling. Special attention, however, should reduce these losses considerably. Collecting pans should be placed under all milk apparatus where milk is apt to spill, and especially under the filling machines.

FIGURE 8.—Checking out routes at a milk plant using three conveyors which load out the milk direct from the storage room. The goods delivered to each driver are charged by the checker on a driver's order (Form 7)

CHECKING MILK THROUGH THE PLANT

Every milk plant, whether large or small, should have as part of an adequate accounting system a method of keeping a check on all milk received and handled through the plant and of checking the route salesmen. (Fig. 8.) Following are given some of the forms that may be used for these purposes at small or medium-sized plants. No attempt to describe the general accounting system is made.

CHECKING GOODS HANDLED IN PLANT

Many milk losses in a plant are sometimes overlooked. For example, a driver may go out with more milk than is charged to him, or he may receive credit for returning more milk than he actually returns, or milk may be sent out on special delivery and not be charged. In order to check up such mistakes and losses, a balance of all goods handled at the plant should be made out each day.

The daily stock balance sheet shown in Form 1 is adaptable for use in any milk plant which operates up to 10 or 15 milk-delivery

wagons and handles very little butter, cheese, or other manufactured goods; it is especially suitable for use in a branch plant which receives most of its special goods, such as cream, chocolate drink, butter, etc., from the main plant. This stock balance is used as follows:

An inventory of the stocks on hand may be taken at any definite time during the day, depending upon conditions at the plant, as 6 p. m.; but the inventory should be taken at the same time each day and must be carried forward on the balance for the following day. For example, the quantities of milk, cream, and other products credited in the horizontal column headed "Stocks on hand at 6 p. m. Tuesday," which is shown near the bottom of the sheet, are carried forward to the top column of the upper or debit side of the next sheet as "stocks on hand" to be accounted for on the following day (Wednesday). To this item are added all goods received at the plant from producers and other receipts during the day. The total of these three items is the total amount of stocks to be accounted for on that day. On the lower half or credit side of the balance are entered all sales, known losses, etc. The sum of the total quantity of each kind of goods thus credited and the quantity on hand should equal the total amount to be accounted for.

In the line headed "Transferred" on the upper or debit side of the sheet are entered the quantities of cream, skim milk, etc., made from other products, as, for example, cream of a medium butterfat content made from heavy cream and skim milk, or cream and skim milk obtained by separating whole milk. The quantities of these new goods are to be added to the stocks on hand and the receipts, in order to determine the "total stocks to be accounted for." To balance the account it is necessary to enter the quantities of old goods used for these purposes on the credit side under "Transferred." Thus, if 100 gallons of whole milk were separated into 10 gallons of cream and 90 gallons of skim milk, the 100 gallons of whole milk would be entered on the credit side of the balance and the 90 gallons of skim milk and 10 gallons of cream would be entered on the debit side; or if 100 gallons of cream of medium butterfat content were made from 80 gallons of heavy cream and 20 gallons of skim milk, the 100 gallons of medium cream would be entered under "Transferred" on the debit side and the heavy cream and skim milk would be entered under "Transferred" on the credit side of the balance sheet.

If all records are carefully completed each day, there should be only a small surplus or shortage unaccounted for at the end of the day. If on any day a considerable shortage is shown, the plant superintendent should immediately attempt to find its cause.

Another plan for balancing the stock handled at the plant during the day is the use of Form 2. This sheet is designed more especially for plants with, in addition to the market-milk department, other departments, such as cream or separating department, butter department, etc. This balance should be supplemented by other checks, such as "separator report," "butter-department report," "pasteurizing and bottling report" (Form 3), etc. All goods received are debited, and all goods sent to the routes or to other departments, known losses, etc., are credited. Form 2 may be used by plants of all sizes. It does not, however, supply a check on any losses on the routes because the entries on the credit side show the quantities of goods delivered to the drivers and not the actual sales as does Form 1.

Form 1.—Daily Balance of Stock

Date ---------- 193--

DEBIT

	Milk					Special milk		Butter-milk		Skim milk		Cream					XX cream				Chocolate drink				Butter, pounds
	Gallons	Quarts	Pints	⅓ quarts	½ pints	Quarts	Pints	Gallons	Quarts	Gallons	Quarts	Gallons	Quarts	Pints	½ pints	Gills	Quarts	Pints	½ pints	Gills	Quarts	Pints	⅓ quarts	½ pints	
Stocks on hand, 6 p. m., *Monday*	200	1,600	800			50		10	200	10			10	30	200		22	6	20	20				200	30
Received from producers	800																								
Received from main plant																									
Other receipts						50		10	180				10	20	200		2	5	15	30				220	50
Transferred												[1] 10													
Total stocks to be accounted for	1,000	1,600	800			100		20	380	10		10	20	50	400		24	11	35	50				420	80

CREDIT

Sales, Route 1	20	200	50			6		5	50				5	5	50		1		5					50	10
Route 2	5	300	100			10			50						30			3	5	10					
Route 3	50	250	100			4			20				2	5	25			2						50	10
Route 4	50	200	150			10			30					2	25										
Route 5	50	200	50			10			10				3	10	20				3					20	
Route 6 (etc.)		350	150						10					3	20					5				30	
Office sales		30	10			5									10				2						5
Special deliveries		50	20					3	20			10		2			2	2	8	5				20	10
Shrinkage in pasteurizing and bottling department	10																								
Other known losses		10	10											1	4									2	
Returned to shippers	5																								
Returned to main plant	10					2			5																
Transferred										[1] 5							[1] 20								
Total amount credited	200	1,590	640			47		8	195	5		10	10	28	184		23	7	33	20				172	35
Stocks on hand, 6 p. m., *Tuesday*	300	1,670	800			53		12	184	5			10	22	214		1	4	12	30				248	45
Total stocks accounted for	500	3,260	1,440			100		20	379	10		10	20	50	398		24	11	35	50				420	80
Over		1,660	640																						
Short	[2] 500								1						2										

[1] 10 gallons of cream were made from 20 quarts of XX cream and 5 gallons of skim milk.

[2] Net shortage of milk, 500−(1660/4+640/8)=5 gallons.

FORM 2.—DAILY BALANCE OF RECEIPTS AND DISPOSALS OF STOCK AT PLANT Date_____193__

DEBIT

	Milk		Special milks		Cream		XX cream		Buttermilk		Skim milk		Chocolate drink		Butter, pounds	Miscellaneous
	Gallons	Pints	Gallons	Pints	Gallons	Pints	Gallons	Pints	Gallons	Pints	Gallons	Pints	Gallons	Pints		
Stocks on hand, 6 p. m. (*previous day*)	2,000	6	10		80	2	20		280		100		10			
Received from producers	2,000															
Received from branches			10										10			
Standardizing																
Returned from routes																
Manufactured					[1] 40				[2] 300							
From separator							[3] 50				[3] 450					
Total receipts	4,000	6	20		120	2	70		580		550		20			

CREDIT

Returned to shippers																
To retail routes	1,500		10		60		20		290				10			
To wholesale routes	400															
To retail department of plant																
Special deliveries	100															
To separator	[3] 500															
To ice cream department																
To butter department																
To standardizing							[1] 20				[1] 20					
To buttermilk											[2] 300					
To chocolate drink																
Other deliveries																
Known losses	30				2				10					4		
Stocks on hand, 6 p. m. (*to-day*)	1,470		10		60		30		280		230		9	4		
Total distribution	4,000		20		120	2	70		580		550		20			
Over																
Short		6														

Spilled and leaked																
Breakage						2			5							
Drunk by employees																
Shrinkage in pasteurizing and bottling	30								5					4		
Loss in separating																
Loss in dumping returns																
Other losses																
Total losses	30					2			10					4		

[1] 40 gallons of cream were made from 20 gallons of XX cream and 20 gallons of skim milk.
[2] 300 gallons of buttermilk were made from 300 gallons of skim milk.
[3] 50 gallons of XX cream and 450 gallons of skim milk were separated from 500 gallons of milk.

CHECKING LOSSES IN PASTEURIZING AND BOTTLING

The accompanying form (No. 3) may be used to check the losses of milk and other products that take place during the processes of pasteurizing and bottling. Such shrinkages may be reported in both volume and percentage. Such a check should be kept at all plants and should be used in conjunction with the daily balance of stock. (Form 1 or Form 2.) The quantity lost as indicated by Form 3 will be entered under this item on the credit side of Forms 1 or 2 showing daily balance of stock at plant.

FORM 3.—PASTEURIZING AND BOTTLING REPORT

Date _____ 193__

	Milk				Buttermilk		Cream				Chocolate drink		
	Quarts	Pints	½ pints	Total gallons	Quarts	Total gallons	Quarts	Pints	½ pints	Total gallons	Pints	½ pints	Total gallons
Receipts of the pasteurizing and bottling department:													
Milk and cream received from the producers				2,000						50			
Cream received from separator department										150			
Other receipts (buttermilk, chocolate drink, etc.)						300							10
Total receipts of pasteurizing and bottling department				2,000		300				200			10
Products delivered to the cold-storage room by the pasteurizing and bottling department	6,000	3,000	1,680	1,980	1,192	298	112	160	2,400	198	20	120	10
Excess (+) or shrinkage (−):													
Gallons				−20		−2				−2			
Per cent				1.00		0.66				1.00			

CHECKING THE SHIPPING AND RECEIVING CLERKS

Unless the proprietor himself checks the route men out and in, it is important that a check be kept on the shipping and receiving clerks. When the shipping clerk takes charge of the milk-storage room at night, he should check the dayman's inventory of "stocks on hand," which also appears at the bottom of the balance sheet of the plant operations. (Form 1 or Form 2.) He must account for these stocks by deliveries to the various routes, etc. Form 4 may be used for this purpose after the dayman's inventory is checked. The shipping clerk enters the quantity of goods on hand in the line, "On hand 6 p. m.," in Form 4, as the amount to be accounted for. He next enters the quantity of goods delivered to the various route men, any cash sales, quantity broken or spilled, etc. To these items is added the quantity of goods on hand when he has completed his night's work. This total should equal the quantity on hand the previous evening. The inventory taken by the shipping clerk should be checked by the dayman when he takes charge of the milk-storage room.

FORM 4.—SHIPPING CLERK'S BALANCE

Date _____ 193__

	Milk			Cream					But-ter-milk	Skim milk		But-ter	Cheese
	Gallons	Quarts	Pints	Gallons	Quarts	Pints	½ pints	¼ pints	Quarts	Gallons	Quarts	Pounds	Packages
Stocks on hand, 6 p. m	100	2,000	800	10	2	8	400		100			10	20
Disposal of stocks:													
Delivered to—													
Route 1	10	300	50	5		2	50		20				
Route 2		300	100	5			100		30			5	
Route 3	10	300	100			2	50		30				10
Route 4		410	150				50						
Route 5 (etc.)		300	200			2	50		10				
Cash sales							10						5
Broken or spilled		10					5		1				
Total disposed of	20	1,620	600	10		6	315		91			5	15
On hand, 7 a. m	80	380	200		2	2	80		8			5	5
Total accounted for	100	2,000	800	10	2	8	395		99			10	20
Over													
Short							5		1				

The man who checks in the routes may be checked by the use of Form 5. He is charged with all goods which he has credited the route men with returning (Form 8), and is credited with the quantity he turns over to other departments, or has on hand at the end of the day. Forms 4 and 5 are valuable for checking both the accuracy and the honesty of the shipping and receiving clerks. Any considerable shortage indicates that one or more of the route men received more goods than were charged to him or returned less goods than he was credited with.

FORM 5.—RECEIVING CLERK'S BALANCE

Date _____ 193__

	Milk			Cream					But-ter milk	Skim milk		But-ter	Cheese
	Gallons	Quarts	Pints	Gallons	Quarts	Pints	½ pints	¼ pints	Quarts	Gallons	Quarts	Pounds	Packages
Receipts:													
Received from—													
Route 1	1	10	9			2	10		5			1	
Route 2		50				4	10		8				
Route 3	1	10	10				5		3			1	
Route 4		6	5			2	5		4			2	
Route 5 (etc.)	2	20	8				2						
Total to account for	4	96	32			8	32		20			4	
Deliveries:													
To butter department				2								4	
To by-products department	31	2											
Other deliveries													
On hand, 6 p. m									20				
Total accounted for	31	2		2					20			4	
Over													
Short		2		1									

FORM 6.—REPORT FOR MILK COOLER BALANCE

	Milk					Certified milk	Special milk		Buttermilk		Cream				Double cream			
	Gallons	Quarts	Pints	½ pints	⅓ quarts	Quarts	Quarts	Pints	Gallons	Quarts	Gallons	Quarts	Pints	½ pints	Gallons	Quarts	Pints	½ pints
Receipts:																		
In cooler, 7 a. m.	100	100				2	4		10	10	10					2		10
Received from bottling department		2,000	800							800		4	4	400		1	2	50
Received from other departments	200					20	100		[1] 80		[1] 20							
Converted																		
Total	300	2,100	800			22	104		90	810	30	4	4	400		3	2	60
Disbursements:																		
To pasteurizing department																		
To separator	[1] 100					2	4											
To standardizing cream																		
Converted																		
To retail routes		20	45															
To wholesale routes											5	4		30				
To special delivery routes		20							10		5							
To retail store		50	50							20				20				18
To known losses		5	5							10								
In cooler, 6 p. m.	200	2,000	700			20	100		80	780	20		4	350		3	2	40
Total	300	2,095	800			22	104		90	810	30	4	4	400		3	2	58
Over																		
Short		5																2

[1] 100 gallons of milk were separated into 20 gallons of cream and 80 gallons of skim milk; and 80 gallons of buttermilk were made from this skim milk.

MILK-COOLER REPORT

Form 6 may be used as a check on the man who has charge of the milk cooler or milk-storage room during the day. The quantity of goods in the cooler when he takes it over should check with the inventory as reported by the shipping clerk or night man. To this is added all goods transferred to the cooler from the bottling department or other departments during the day and the total of these items is the amount to be accounted for. Under "Disbursements" are entered the quantities of all goods transferred from the cooler to various departments during the day; also all deliveries to the routes. To these items are added the quantities of the various products on hand at the end of the day, and this total should equal the total to be accounted for above. The man in charge of the cooler should not give out any goods except on receipt of the proper order.

CHECKING THE DRIVER

Each driver should be charged with the goods he takes out on his route and credited for all goods returned. Forms 7 and 8 may be used to check the routes out and in.

When the driver comes in from his route he makes out his order for the following day on Form 7. This quantity is put up the same day by the plant, and given to the driver when he loads the following morning. If changes are made before the driver leaves, these may be noted under "Extras."

FORM 7.—DRIVER'S ORDER

Route _____ Date wanted _____ 193__

	Milk			Cream					Butter-milk	Skim milk	Butter
	Gallons	Quarts	Pints	Gallons	Quarts	Pints	½ pints	¼ pints	Quarts	Gallons	Pounds
Order	15	205	105				15		20		5
Extras	5	5									
Total	20	210	105				15		20		5

On his return from the route the driver enters the quantity of goods returned on the record shown in Form 8. The difference between the totals on Forms 7 and 8 is the amount of net sales for the day or the amount the driver must account for. The driver is also given credit on Form 8 for all bottles returned.

FORM 8.—DRIVER'S RETURN RECORD

Route _____ Date returned _____ 193__

	Milk			Cream					Buttermilk (qts.)	Skim milk (gals.)	Butter (lbs.)	Bottles returned			
	Gallons	Quarts	Pints	Gallons	Quarts	Pints	½ pints	¼ pints				Quarts	Pints	½ pints	¼ pints
Returned	10	10	5				5				5	150	150	20	
Returned second trip															
Total	10	10	5				5				5	150	150	20	

Form 9.—Driver's Daily Report [1]

[Front of sheet]

Route No. _____ Driver _____ Date _____ 193__

Item	Out first trip	Out second trip	Total out	Returned	Net sales	Retail sales: Sales	Retail sales: Price	Retail sales: Value	Wholesale sales: Sales	Wholesale sales: Price	Wholesale sales: Value	Total value of net sales
Milk:	*Vol.*	*Vol.*	*Vol.*	*Vol.*	*Vol.*	*Vol.*	*Cents*		*Vol.*	*Cents*		
Gallons			*20*	*10*	*10*				*10*	*35*	*$3.50*	*$3.50*
Quarts			*210*	*10*	*200*	*150*	*12*	*$18.00*	*50*	*10*	*5.00*	*23.00*
Pints			*105*	*5*	*100*	*100*	*7*	*7.00*				*7.00*
½ pints												
⅓ quarts												
Special milk:												
Quarts												
Pints												
Certified milk:												
Quarts												
Pints												
Buttermilk:												
Gallons												
Quarts			*20*		*20*	*20*	*10*	*2.00*				*2.00*
Cream:												
Gallons												
Quarts												
Pints												
½ pints			*15*	*5*	*10*	*10*	*20*	*2.00*				*2.00*
XX cream:												
Gallons												
Quarts												
Pints												
½ pints												
Skim milk:												
Gallons												
Quarts												
Chocolate drink:												
Pints												
½ pints												
Cheese:												
Packages												
Pounds												
Butter: Pounds			*5*	*5*								
Miscellaneous												
Total												*37.50*

CASH ACCOUNT

Cash turned in:	
Cents	
Nickels	
Dimes	
Quarters	*$5.00*
Half dollars	*5.00*
Dollars	
Currency	*10.00*
Checks—	
A	*5.00*
B	
C	*5.00*
D	
E	
F	
G (etc.)	
Total cash	*30.00*
Distribution of cash received: [2]	
Cash received on account. (See other side)	*3.50*
Cash for tickets. (See other side)	*20.00*
Cash sales	*6.50*
Total cash	*30.00*

SALES REPORT [2]

Wholesale charges. (See other side)	*$3.50*
Retail charges (as per route book)	*10.00*
Loose tickets turned in	*17.00*
Cash sales	*6.50*
Total sales	*37.00*
Over	
Short	*.50*

TICKET ACCOUNT [2]		CREDIT REPORT [3]			
		Balance		Credits	
Outstanding tickets charged to driver	$10.00	**Total value of net sales** [4]	$37.50	**Cash turned in**	$30.60
Tickets delivered to driver to-day (Book Nos. —)	10.00	**Add any tickets delivered to driver**	2.00	**Loose tickets turned in**	1.00
		Add other charges to driver		**Office credits**	3.00
Total	20.00	**Total charges to driver**	39.50		
		Total credits	34.00	**Total credits**	34.00
Tickets charged to customers on account					
Tickets sold for cash	20.00	**Balance**	4.50	Bottles out ..... number	350
Balance charged to driver		**Add yesterday's outstanding balance**	90.50	In ..... do	340
Total	20.00	**Balance outstanding to-day**	95.00	Over ..... do	
				Short ..... do	10

[Back of sheet]

Name	Address	Page No.	Cash	Charge	Name	Address	Page No.	Amount collected
Ticket sales			$20.00		Collected on account			$3.50
Wholesale sales			5.00	$3.50				

[1] This form can be used at plants where sales are made for cash or tickets and at plants where sales are charged in a route book.
[2] This section is for use at plants where the ticket or cash system is used.
[3] This section is for use at plants where the credit system is principally used.
[4] "Tickets" and "Other charges," if any, are added to the total for "Total value of net sales," given above, to determine the "Total charges to driver."

DRIVER'S DAILY REPORT

Form 9 shows a daily report sheet which may be used to account for the goods charged to the driver each day. The quantities of milk, cream, and other goods taken out by the driver, minus the quantities returned, are his net sales which he must account for. The sales to the retail and wholesale trade are figured at the prices charged to the trade, giving the total value of the net sales.

When the ticket system is used the driver accounts for his net sales by filling in the "Sales report" section of Form 9, under which he reports loose tickets turned in, cash sales (wholesale and retail), and the amounts he has charged to any customers who have charge accounts, whether wholesale or retail. The total for these items in the "Sales report" section should equal the total value of the net sales. He accounts for the tickets charged to him under the section headed "Ticket account."

As a rule, the driver will fill in the various items under "Cash account." The total distribution of the cash must of course check with the total amount of cash turned in, and the "Cash sales" in "Distribution of cash received" should check with the "Cash sales" in the "Sales report." On the reverse side of the report sheet he may list his ticket sales and wholesale cash sales. He may also list the amounts collected on account from charge customers. He will also list the amounts charged to wholesale customers, the total of which is the amount of wholesale charges listed under the "Sales report." All totals will be checked by the office checker, who will also check the amount of cash and loose tickets turned in.

Where the majority of the retail customers have charge accounts and a route book is used, the driver would not use the "Ticket account," the "Sales report" section, or the reverse side of the report sheet in Form 9. He lists all cash turned in, as well as loose tickets (when the ticket system is used for some of the customers), and any other credits under "Credits" in Form 9. He accounts for his net load in the vertical space provided directly below the column headed "Total value of net sales." To the total value of the net sales are added the value of any tickets delivered to the driver, and any other charges incurred during the day. From the "Total charges to the driver" are subtracted the "Total credits." To this remainder is added the amount of outstanding charges for the previous day, and the balance is the amount that should be outstanding in the route book. If the "total credits" is greater than the "total charges to driver," the latter is subtracted from the former, and the difference is subtracted from the "outstanding balance" for the previous day. In that case, the excess of total credits over total charges may be indicated in a different colored ink. The outstanding charges in the route book need not be checked each day, and for the ordinary route will not be checked until the end of the month. Where the driver is likely to make mistakes, however, the route book should be checked more often.

At the end of the month the route book must be checked to see that the outstanding charges in it agree with the "Balance outstanding" indicated on Form 9. If the balance indicated on Form 9 is greater than the total amount as indicated by the route book, the difference is the amount the driver is short.

MONTHLY SUMMARY OF DRIVER'S DAILY REPORTS

At the end of the month all the drivers' daily reports may be recapitulated on the "Monthly summary of drivers' daily reports." (Form 10.) Each summary should contain a complete record, for each route, of all sales and credits. The summaries will also show the amount of milk and other goods that each driver is over or short, if the ticket system is used; or they will show the amount that should be outstanding on each route book, if the credit system is used. The totals of all these summaries will contain a complete record of the business done for the month. This form can be modified to suit the particular plant, depending upon whether the ticket or the credit system is used.

ROUTE BOOK

At plants where the credit or open-account system is used, it is necessary for the route salesmen to have a route book. In this book are listed the names and addresses of all customers on the route, one page being used for each customer. Usually each page will contain the record of one charge customer for one month, but in some cases the page is so arranged that it may contain the records for three to six months. A sample page of a route book similar to that used by many milk plants is given in Form 11. The customers are usually listed in the route book in the order that they are served on the route. The book may be loose leafed, if desired, and in that case any changes in or additions to the list of customers can readily be taken care of in the route book. The route salesman usually "scores" his book daily on his return from his route. In some cases where the customers usually take the same quantity of milk, cream, or other goods from day to day it is not necessary to score the book every day. For accounts on which this practice is followed, the route salesman may enter the quantities delivered to each customer for the first three days of the month and make no further entries unless there is a change in the order. Whenever there is a change in the order he will again score such customers for a period of three days with no further entries unless the order is again changed. All credits to the customers are entered opposite the proper date either by the route salesmen or the office. At the end of the month or week (when weekly bills are rendered) the customers' bills will be made out from the records in the route book.

Form 10.—Summary of Driver's Daily Reports for One Month

Route No. _____ Driver _____ Month of _____

Day	A																										B			C							D			
	Net sales																										Value of net sales			Sales report							Total charges and credits to driver			
	Pasteurized milk					Special milk		Certified milk		Buttermilk		Cream				XX cream				Skim milk		Chocolate drink		Other goods																	
	Gallons	Quarts	Pints	¼ quarts	½ pints	Quarts	Pints	Quarts	Pints	Gallons	Quarts	Gallons	Quarts	Pints	½ pints	Gallons	Quarts	Pints	½ pints	Gallons	Quarts	Pints	½ pints				Wholesale sales	Retail sales	Total net sales	Wholesale charges	Retail charges	Loose tickets	Cash sales	Over	Short	Cash turned in	Tickets delivered to driver	Total charges to driver [1]	Total credits to driver [2]	Balance outstanding
																											$	$	$	$	$	$	$	$	$	$	$	$	$	$
1																																								
2																																								
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16																																								
30																																								
31																																								
Total																																								

[1] Total net sales plus value of tickets delivered to driver.

[2] All cash turned in.

Note.—Sections A, B, and C are to be used where the ticket system is used, and sections A, B, and D are to be used where the credit system is used with route book.

FORM 11.—SAMPLE PAGE OF ROUTE BOOK [1]

Page No. *45*. Account No. *45*. Date: *Sept., 1932.*

Name: *John Smith.* Daily order: *1 quart milk, ½ pint cream.*

Address: *50 Maple St.* Directions: *Backdoor.*

	Milk		Cream		Other goods	Charge	Credit
	Quarts	Pints	Pints	½ pints			
Price	*$0.12*			*$0.20*			
Balance from previous month						*$10.00*	
1	*1*			*1*			
2	*1*			*1*			
3	*1*			*1*			
4	*1*			*1*			
5	*1*			*1*			
6	*1*			*1*			
7	*1*			*1*			
8	*1*			*1*			
9	*1*			*1*			
10	*1*			*1*			
11	*1*			*1*			
12	*2*			*1*			
13	*1*			*1*			
14	*2*			*1*			
15	*1*			*1*			*$8.00*
16	*2*			*1*			
17	*1*			*1*			
18	*1*			*1*			
19	*1*			*1*			
20	*1*			*1*			
21	*1*			*1*			
22	*1*			*1*			
23	*1*			*1*			
23	*1*			*1*			
23	*1*			*2*			
24	*1*			*2*			
25	*1*			*1*			
26	*1*			*2*			
27	*1*			*1*			
28	*2*			*1*			
29	*2*			*1*			
29	*1*			*1*			
30	*1*			*1*			
31							
Total	*35*			*33*		*20.80*	*8.00*
Balance forward						*12.80*	

[1] 1 page for each charge customer.

At the end of the month, or more often if necessary, the route book is checked over to determine the total amount that is due from the customers. The total of these unpaid balances is the amount outstanding, and should check with the "Balance outstanding to-day" at the bottom of Form 9 for that particular date. If the amount outstanding on the book were less than the amount indicated at the bottom of Form 9, this difference would indicate that the driver had failed to turn in some of the payments he had received, or had made some other error, and would be the amount he is short for the month.

These route books are usually of a size that will fit the route salesman's pocket. In some cases, instead of having a column for each product, space is saved by using special symbols to indicate the goods delivered to the customer, so that fewer columns are required. For example, 1, −, and + may be used to denote a quart of milk, a pint of milk, and a half pint of cream, respectively.

NUMBER OF MEN REQUIRED TO OPERATE A MILK PLANT

The number of men required to operate a milk plant depends on the quantity of milk handled, the proportion bottled, and the type and arrangement of the plant and methods of operation. A well-arranged plant of one or two stories requires less labor per 100 gallons handled than a poorly arranged plant or one of several stories (7). In plants where most of the milk is bottled, more men will be required to handle a given quantity of milk than in plants where a larger proportion of the milk is put out in bulk.

Table 5 shows the average number of men employed in milk plants of various sizes. There were wide differences in the numbers of men employed at plants of approximately the same size, but the average number shown in the table will give a general idea of the number required to operate a plant of a given capacity. It will be noted that as a rule more milk is handled per man employed at the large plants than at the smaller ones. At large plants the same crew of men are often employed on the same job for the full day, whereas at the small plants it is necessary to shift the men from one job to another. This specialization of labor naturally results in certain economies in operation at the larger plants.

TABLE 5.—*Number of men employed in 194 city milk plants (men inside the plant only)*

Size of plant—quantity handled daily (gallons)	Plants	Average quantity handled daily per plant	Average employees inside plant [1]	Milk handled per plant employee
	Number	*Gallons*	*Number*	*Gallons*
Up to 100	4	63	1.1	58.8
101 to 250	19	173	1.7	100.0
251 to 500	31	401	2.8	142.9
501 to 1,000	34	790	5.7	142.9
1,001 to 1,500	16	1,297	7.2	166.6
1,501 to 2,000	11	1,782	11.5	166.6
2,001 to 5,000	21	3,308	15.3	216.0
5,001 to 10,000	34	7,342	34.5	213.0
10,001 to 15,000	9	11,504	46.0	249.0
15,001 to 20,000	8	17,393	78.6	221.0
Over 20,000	7	27,448	103.0	267.0

[1] Including all men whose time was chargeable to the market-milk department. If they were used in other departments also, time was prorated. Clerks and bookkeepers not included.

The number of men employed at 115 plants of various sizes ranged from 2.5 to 6 in small plants of 1,000 gallons capacity or less, up to 59 to 135 in plants handling over 20,000 gallons. (Table 6.) There are also wide variations in the number of gallons handled per plant employee at plants of similar capacities. While these variations are in part due to such factors as the proportion of bottled and bulk goods put out, they also indicate that some plants are operated more efficiently as to labor used than others of similar capacity. One of the reasons for this is that some plants are arranged more economically than others from the standpoint of labor required (7).

TABLE 6.—*Variation in number of gallons of milk handled per plant employee at 115 plants*

Gallons of milk handled per day	Plants	Average quantity of milk handled daily per plant	Employees in plant		Milk handled per plant employee	
			Average	Variation	Average	Variation
	Number	*Gallons*	*Number*	*Number*	*Gallons*	*Gallons*
1,000 or less	4	963	5.4	2.5 to 6	188	158 to 360
1,001 to 2,000	21	1,630	7.4	4 to 14	221	135 to 350
2,001 to 3,000	13	2,482	9.7	6 to 16	253	175 to 375
3,001 to 5,000	22	4,190	19.6	10 to 30	214	150 to 350
5,001 to 10,000	37	7,175	32.8	16 to 52	231	146 to 375
10,001 to 20,000	12	15,603	65.8	39 to 90	237	166 to 325
Over 20,000	6	24,833	96.0	59 to 135	259	178 to 385
Total	115					

NUMBER OF MEN IN DELIVERY AND OFFICE DEPARTMENTS

The average number of routes, route foremen, and clerical workers at 216 city milk plants, arranged in groups according to plant capacity, are shown in Table 7.

TABLE 7.—*Number of routes, route foremen, and office workers at 216 pasteurizing plants*

Size of plant—quantity handled daily (gallons)	Plants	Average quantity handled daily	Delivery routes			Office workers			
			Routes per plant	Routes per 100 gallons of milk handled daily	Routes per route foreman	Total clerks		Clerks on route and customer records	
						Clerks per plant	Routes per clerk	Clerks per plant	Routes per clerk
	Number	*Gallons*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Less than 100	4	85	1.0	1.2					
101 to 250	18	168	2.4	1.4		0.5	4.7		
251 to 500	31	390	4.4	1.1		0.8	5.7		
501 to 1,000	35	788	9.8	1.2	6.7	2.7	3.7		
1,001 to 2,000	35	1,505	15.6	1.0	[1] 6.5 (33)	3.6 (31)	5.5 (31)	2.4 (5)	10.4 (5)
2,001 to 3,000	22	2,584	27.9	1.1	7.8	5.1 (21)	6.3 (21)	3.4 (7)	10.2 (7)
3,001 to 5,000	29	3,936	36.5	0.9	7.6	6.9	5.8	3.6 (10)	12.0 (10)
5,001 to 10,000	32	7,348	66.7	0.9	7.0 (28)	11.8 (25)	6.3 (25)	6.8 (13)	13.3 (13)
Over 10,000	10	20,000	143.4	0.7	7.2	32.6 (6)	5.1 (6)	16.8 (4)	10.2 (4)

[1] Where the number of plants used was smaller than the total, this is indicated by a number in parentheses. For example, the number (33) indicates that the figures on "routes per route foreman" were based on 33 plants out of a total of 35 plants in the 1,001 to 2,000 gallon group.

On the average the larger plants had fewer routes per 100 gallons handled than the smaller ones. This is due partly to the greater proportion of bulk and wholesale goods handled by the larger plants. The number of routes per route foreman was fairly uniform for plants of all sizes with capacities above 500 gallons of milk daily. At the smaller plants, generally none of the men was specifically designated as route foreman, and in most cases the proprietor looked after the work generally assigned to a route foreman.

The duties of the route foreman or supervisor are varied and only experienced or specially trained men can satisfactorily fill the position. In the first place the foreman must be familiar with each route under his supervision so that he can attend to it in case the regular driver is ill or otherwise unable to do so. Usually he must also be familiar

with the credit standing of the customers on the routes under his supervision, and must check up on his drivers to see that the bills are being collected promptly. The drivers will consult with him on the advisability of discontinuing any customers who are delinquent in payment. Another important duty of the route supervisor is to check up on the accuracy as well as the honesty of the driver in keeping the records in the route books. The route supervisor should be sufficiently familiar with each driver's work to judge for himself the necessity of checking up on the outstanding credit accounts in the route book oftener than once a month. In order that he may be thoroughly familiar with each route under his supervision, it is desirable that the supervisor cover each of them with the regular driver at frequent intervals. He must also be able to judge the general efficiency of each man under his supervision, and to advise the men on how to increase their efficiency. He must be on hand each morning to see that all of his men are present to take care of their routes, as he is responsible for the operation of the routes, and in case any men do not come to work he must provide for covering their routes.

At very small plants with only a few routes the proprietor or manager will usually perform the duties generally required of route supervisors at plants operating a large number of routes.

The number of routes per office clerk differed greatly at plants of similar capacities, and there were more office employees at some of the smaller plants than at some of the larger ones. The number of office clerks required depends greatly on the system of accounting used, some of the plants having an excessively large number because of the detailed and rather cumbersome systems used.

WEIGHTS OF MILK AND CREAM

In general, the specific gravity of milk and cream depends on the percentage and relation of the solids, the temperature at which the determinations are made, and the age of the milk. The weight of 1 gallon of water at 68° F. (20° C.) according to the Bureau of Standards, is 8.32162 pounds. Using this figure as the weight of water, and using the specific gravities of milk and cream of various percentages as given in Miscellaneous Publication 138 (*3*), Table 8 has been worked out to give the weights per gallon, at a temperature of 68°.

TABLE 8.—*Weight per gallon and specific gravity of milk and cream having various fat contents*

Commodity	Fat content	Specific gravity	Weight per gallon	Commodity	Fat content	Specific gravity	Weight per gallon
	Per cent		*Pounds*		*Per cent*		*Pounds*
Water		1.000	8.32162	Cream	25.0	1.008	8.3882
Skim milk	0.025	1.037	8.6295	Do	28.0	1.006	8.3715
Milk	3.5	1.033	8.5962	Do	30.0	1.004	8.3549
Mixed milk and cream	10.0	1.025	8.5297	Do	32.0	1.002	8.3383
Do	15.0	1.018	8.4714	Do	35.0	.999	8.3133
Cream	18.0	1.015	8.4464	Do	38.0	.997	8.2967
Do	20.0	1.013	8.4298	Do	40.0	.995	8.2800
Do	22.0	1.011	8.4132				

Weights are given at 68° F. because that is the temperature used in determining the specific gravities, being equivalent to 20° C., the temperature generally used for such work. There would be a slight difference for milk at 50° to 60° F., the temperature at which milk is usually received at the plant. For all practical purposes the weight of whole milk may be figured at 8.6 pounds a gallon.

STANDARDIZATION OF MILK AND CREAM

It is usually necessary in the milk plant to transform cream from one percentage of butterfat to another. Some plants receive cream of from 30 to 40 per cent butterfat content and wish to make coffee cream containing from 18 to 20 per cent butterfat. Sometimes it is desired to make 30 per cent cream from cream of a higher butterfat content by mixing it with milk or a thinner cream. The Pearson square method is usually used to determine how much of the products available should be used. A series of cream-standardization tables indicating the quantities of the various products required to make cream of any butterfat content desired appears in Department Circular 199 (*17*).

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